

---

---

SANITARY  
HOUSE-INSPECTION

---

GERHARD

---

---



Class TD 918

Book .Q 4



30  
100  
7/20/1





# A GUIDE

TO

# SANITARY HOUSE-INSPECTION;

OR,

HINTS AND HELPS REGARDING THE CHOICE OF A  
HEALTHFUL HOME IN CITY OR COUNTRY.

BY

WILLIAM PAUL GERHARD, C.E.,

*Consulting Engineer for Sanitary Works; Corresponding Member American  
Institute of Architects, Member New England Water-Works Association,  
American Public Health Association, German  
Technical Society of New York, etc.*

AUTHOR OF "HOUSE DRAINAGE AND SANITARY PLUMBING;" "HINTS ON THE  
DRAINAGE AND SEWERAGE OF DWELLINGS;" "DIAGRAM FOR SEWER CALCULATIONS;"  
"THE DISPOSAL OF HOUSEHOLD WASTES;" "SANITARY QUESTIONS;" "THE PREVENTION OF FIRE;" "SANITARY DRAINAGE  
OF BUILDINGS;" "THE DRAINAGE OF A HOUSE;" "DOMESTIC  
SANITARY APPLIANCES;" "GAS LIGHTING AND GAS  
FITTING;" ETC., ETC.

---

Third Edition.

NEW YORK:

JOHN WILEY & SONS

43-45 East 19th St.

1902.

Copyright by  
JOHN WILEY & SONS,  
1885.

WILEY & SONS  
NEW YORK

ROBERT DRUMMOND, PRINTER, NEW YORK.

32111

4-13323/4



## PREFACE TO THE FIRST EDITION.

---

IN the following pages the attempt has been made to outline broadly the main features of a sanitary house-inspection. Although it is hoped that the book may also prove useful to architects, civil engineers, builders, health officers, sanitary inspectors, and family physicians, its principal aim is to instruct the householder.

It was impossible, without unduly enlarging the book, and thus, perhaps, curtailing its usefulness, to give in detail the reasons why certain constructions and arrangements are defective; nor could the right way of doing the work be explained in all cases. The principal scope of the book is to be a guide in the search for defects; and those who have a desire to inform themselves further in these matters would

perhaps do well to refer to the other works of the author,—in particular to his books, “House Drainage and Sanitary Plumbing,” “Hints on the Drainage and Sewerage of Dwellings,” and to his forthcoming works on “Sanitary Architecture,” and “Domestic Sanitary Appliances,” which treat more in detail of matters merely mentioned or hinted at in this volume.

WILLIAM PAUL GERHARD.

6 ASTOR PLACE, NEW-YORK CITY,  
Aug. 1, 1885.

---

### Preface to the Second Edition.

---

A second edition of this book being called for, it is issued substantially unchanged, the author's numerous professional engagements having rendered a thorough revision impossible.

THE AUTHOR.

39 UNION SQUARE, WEST,  
NEW YORK CITY, May 1, 1889.

# CONTENTS.

---

|  | PAGE |
|--|------|
| NECESSITY OF SANITARY HOUSE-INSPECTION . . . . .                   | 8    |
| "SKIN" BUILDINGS . . . . .   | 14   |
| ESSENTIALS OF A HEALTHFUL HOME . . . . .                           | 19   |
| INSPECTION OF CITY HOUSES . . . . .                                | 22   |
| Inspection of the Surroundings and of the Soil . . . . .           | 23   |
| Inspection of the Cellar . . . . .                                 | 25   |
| Inspection of the Yard . . . . .                                   | 26   |
| Inspection of Structural Details . . . . .                         | 27   |
| Inspection of the Sewerage and Plumbing . . . . .                  | 31   |
| Inspection of the Water-Supply . . . . .                           | 53   |
| Inspection of the Method of Garbage Disposal . . . . .             | 55   |
| Inspection of the Arrangements for Warming the House, . . . . .    | 56   |
| Inspection of the Gas-lighting Arrangements . . . . .              | 66   |
| Inspection of the Ventilation of the House . . . . .               | 74   |
| Bad Odors and the Prevention of Dust . . . . .                     | 84   |
| Inspection of Arrangements insuring Safety against Fire, . . . . . | 87   |
| APARTMENT-HOUSES . . . . .   | 90   |
| INSPECTION OF TENEMENT-HOUSES . . . . .                            | 95   |

|   | PAGE |
|---|------|
| INSPECTION OF COUNTRY HOUSES . . . . .                | 99   |
| Healthfulness of Town and Country Houses compared,    | 100  |
| Choice of a Site . . . . .                            | 102  |
| Inspection of the House Foundations and Cellar .      | 104  |
| Inspection of Walls, Roofs, and Rooms . . . .         | 107  |
| Inspection of the Heating-Apparatus . . . .           | 111  |
| Inspection of the Plumbing-Work . . . . .             | 113  |
| Inspection of the Water-Supply . . . . .              | 116  |
| Inspection of Method of Disposal of Household Wastes, | 125  |
| Inspection of the House Surroundings . . . .          | 128  |
| Inspection of the Removal of Storm-water . . . .      | 131  |
| SUMMER BOARDING-HOUSES AND SUMMER RESORTS .           | 132  |
| NECESSITY OF PERIODICAL INSPECTION . . . . .          | 134  |
| ALPHABETICAL INDEX . . . . .                          | 139  |

# A GUIDE TO SANITARY HOUSE-INSPECTION;

OR,

HINTS AND HELPS REGARDING THE CHOICE OF A  
HEALTHFUL HOME IN CITY OR COUNTRY.

---

“How can a house be a safe haven, if in winter the winds pierce it, if in summer the sun scorch it, if dampness rises in its walls, if foul air penetrates its chambers, if by neglect or ignorance the demons of fever enter and lurk therein?”

OLIVER B. BUNCE: *My House, an Ideal.*

THE statement has recently been made, that, “of all the houses put up in the United States, not one in a hundred is made to submit to any official regulation. The local government know nothing of the plans of the builders or architects: there are no sanitary regulations, or attempts to insure protection against fire. No wonder that

whole cities are destroyed by conflagration, and that malaria and disease are common throughout the country! There is no provision by law securing proper drainage, sewerage, or safe construction in ninety-nine out of every hundred houses erected in the United States."

While this may not strictly apply to our largest cities, in which building-laws and sanitary regulations are now in force, yet there cannot be much doubt, that, even in these, there is room for much improvement. That the statements quoted are true of the majority of buildings in smaller cities and towns, and of many of the country and suburban houses annually erected, nobody will deny.

#### NECESSITY OF SANITARY HOUSE-INSPECTION.

Taken as a whole, the warning given ought to serve a useful purpose in calling attention to the serious risks incurred by people in occupying a dwelling without first having made a thorough inspection of the premises. Even if a temporary residence only is contemplated, it would not

appear prudent to neglect such an investigation and inquiry. Health being the supreme consideration, the greatest stress should always be laid upon a detailed examination of the sanitary condition of the home. Nevertheless, in by far the majority of instances, the public exhibits an utter indifference and carelessness with regard to this important matter. In choosing a home, the importance of a wholesome soil, of sound building materials, and of honest workmanship, is apt to be set aside by questions of convenience and fashion, and a number of other considerations of less value. What is the prevalent custom with even well-educated people in choosing a dwelling? Disregarding the question of a salubrious site and of a sanitary construction, they are satisfied if the house stands in a nice street and a fashionable locality, and presents an attractive exterior. On entering such a house, the usual points inquired into are the sizes of the principal rooms, but particularly of the parlor, dining-room, and reception-room; the character of the hard-wood trimmings, of plate-glass mirrors, the elab-

orate decoration of mantle-pieces; the provision made for look-outs, bay-windows, and plenty of closet space; the convenience of fittings, such as electric bells, speaking-tubes, dumb-waiters; the elegance of the plumbing-fixtures so far as they appear visible, in particular of showy marble tops of basins, of silver-plated faucets, costly decorated bowls, and hardwood cabinet-work incasing the plumbing. Briefly, it is the superficial appearance of all *visible* finish which exercises more influence upon intending buyers than the more serious considerations of stability, healthfulness, and safety. Only occasionally does it happen that an inquiry is made into the stability and general character of the structure.

No prudent man would think of buying a house without carefully examining the title of the property; and it is now regarded, in real-estate transactions, as a necessary expenditure to pay competent lawyers for services rendered in securing evidence as to the correctness of the title of a property before concluding any bargain. But not one out of a hundred or more purchasers



would deem it of sufficient importance to secure a certificate from an expert that the house is built in accordance with sanitary rules and regulations. And yet, if the buyer intends to make the house his future residence, his own health, and that of his family and household, will depend upon its cleanliness and salubriousness. The same remarks apply, with equal force, to houses for rent, located in the city, in the suburbs, or in the country. With all the weight of his experience as a sanitarian, Col. Waring advises :—

“Let no family man lease any house without a guaranty of its sound sanitary construction. The question of value is too trifling to be thought about ; and, as the world goes, houses are not less valuable because their plumbing is defective. We run the risk of losing, not money, but health and life ; and these can be secured by the guaranty of no house agent or owner. It is a case where we need the guaranty of absolute knowledge. We ought not to hazard the safety of our family by moving them into, or by keeping them in, a house whose pipes and drains we do not *know* to be

absolutely tight and strong, and to be suitably arranged as to connections, traps, and ventilation. Positive knowledge that the plumbing-work is in this sound condition is the only guaranty that the head of a family, whose eyes have been opened to the dangers of defective work, would be justified in accepting."

It may not seem out of place to utter a word of caution to intending buyers or lessees of houses, old or new, as to the acceptance of general and indefinite statements made to them by real-estate agents. Let it be understood, that it is not, at the present time, a part of the business of an agent to demonstrate the healthful condition of a property. He is simply acting in the interest of the owner or landlord who commissioned him to sell or to rent, as the case may be, a house, at as high a price, and under as favorable terms, as he may be able to secure. Undoubtedly, the time is near at hand when it will be considered indispensable for agents and owners to produce a certificate of the healthfulness and sound construction of a house; and the natural consequence must be that houses hav-

ing such proper sanitary certificate will command a much better price, and find a more ready sale. At present, however, the duty devolves upon the intending purchaser or lessee to secure expert evidence that a house is properly arranged and built as regards its situation and subsoil, its construction, its ventilation, warming, lighting, and protection against fire, and its system of water-supply and sewerage. So good an authority in England as Mr. William Eassie, C. E., says:—

“The wisdom of not entering upon residence in any old house until its healthy condition is vouched for by some competent authority, it would be a work of supererogation to affirm, seeing how many sicken and perish for want of the most ordinary care in this respect. In town and in country alike, when this precaution has been neglected, Nemesis, in the form of some indisposition or another, is certain to overtake the careless occupant. This axiom is, unfortunately, applicable to modern houses built within the present decade, as many a sorrowing heart can testify.”

The conclusions at which we must arrive, from

an earnest and thoughtful consideration of the facts stated, are, that before choosing for occupancy a home, in city or country, a householder should take the precaution to inquire carefully into its healthfulness and the character of its surroundings. A little time devoted to such a preliminary investigation, and a consideration of the facts elicited, are always well worth the trouble, and may save much subsequent illness, especially of those members of the family who are obliged to spend the greater part of each day at home. Those who can ill afford the time required for an investigation, or do not feel themselves competent to pass judgment, should not hesitate to ask expert advice in a matter which may hereafter affect the well-being of those whom they love most. It is particularly true of dwelling-house sanitation, that "an ounce of prevention is better than a pound of cure."

#### "SKIN" BUILDINGS.

In cities and in rapidly growing suburbs it will be advisable to avoid, by all means, the cheap houses of the speculative or "jerry" builder, which

are run up by the hundreds in an incredibly short time, without any considerations whatever of rules governing healthful house-construction; and if they bear a displayed advertisement of having been built "by day's work," and of being provided with perfect "*sanitary* plumbing and *sanitary* heating," we will not, generally, be far from right if we look upon them with all the more suspicion. Such "skin" houses may easily be recognized, however attractive they may be in outside appearance, by an inferior workmanship of details of construction other than those relating to sanitary arrangements. Health, comfort, convenience, and sound construction are, with them, too often sacrificed to mere outward elegance and fashion. Wherever we find that a house has settled considerably, owing to poor foundations, and exhibits walls full of cracks; wherever the brick-work is laid with the poorest kind of mortar; wherever the outer walls appear wet or splashed, owing to window-sills that do not project beyond the walls, and are not grooved on the under side so as to throw the water clear of the walls; wherever the plastering is unsatisfacto-

rily done, and does not show well-planed and true surfaces ; wherever floor-boards are loose, or show wide cracks favoring the accumulation of dirt and dust, and forming harboring-places for vermin ; wherever door-frames are out of plumb, and doors, windows, and shutters constructed of unseasoned wood, with panels full of cracks ; wherever gas-fixtures hang out of plumb, or rattle with every footstep, owing to insufficient strength of the joists ; wherever locks refuse to work, window-sashes stick, and sash-ropes are torn ; wherever the paint soon scales or wears off ; wherever the cold-air box is constructed of a poor material, with a multitude of cracks and crevices ; wherever hot-air flues are insufficient in size, and carried close to unprotected wood-work ; wherever, finally, the whole plumbing-job appears to be "scamped," — there we may, with a tolerable degree of certainty, assume that sanitary considerations have been neglected, that the sanitary work was imperfectly done, even if the building and health regulations have, to all superficial appearance, been complied with. For it must be remembered, that, even in those

cities where building and sanitary regulations are in force, and a large corps of efficient building and sanitary inspectors exercise a supervision of work in new buildings, it is very difficult to prevent intentional frauds on the part of unscrupulous builders. As regards drainage and plumbing of buildings, in particular, there always remains a chance for doing defective work, or using improper or poor materials, without necessarily violating any of the official regulations.

One cannot live in a house of this kind, even if only completed just before occupation, without having before long serious defects appear, necessitating frequent and expensive repairs. Flues will not draw, being roughly and improperly constructed without smooth lining, and made insufficient in size; fire-places will smoke; the furnace will not heat a house, although a brisk fire turns the iron red-hot; water-pipes and traps will constantly freeze and burst in mid-winter, owing to carelessness of arrangement and to the light weight of lead used; faucets soon wear out, and drip; gas-flames burn with an unsteady, dim light,

owing to the insufficient size of the gas-service pipes ; roofs will leak ; dampness and mould will appear in the cellar ; and sewer air from abominable pan-closets and dried-up cellar traps will soon fill the house. Living in such a house means having not only the constant annoyance of mechanics trying to repair an originally bad job, but — and this is infinitely more serious — it means frequent calls for the family physician, or continued low state of health of your wife and children. Avoid such houses, by all means.

But, even where outward indications do not warrant the conclusion that a house is unsafe to live in, it is well to examine the building thoroughly, from cellar to garret, or to get an expert to make a report upon its condition. The investigations of the last twenty-five years, in preventive medicine, have advanced the knowledge of the laws of hygiene, and of the conditions favorable to health, to such an extent, that it is feasible to establish fundamental rules with regard to healthful house-construction. This is as far as the duty of medical men should extend. It de-



volves upon architects and engineers to apply their practical knowledge in carrying out such arrangements and details of construction as are best adapted to secure healthful conditions. In sanitary house-inspections, the principal aim is to inquire if such rules have been followed; and, if not, wherein and how far they have been violated. Sanitary house-inspection covers so many points worthy of discussion, that it seems difficult to touch, in a brief essay, upon all features requiring attention, but an effort is made in the following pages of giving at least the chief points which such an examination should embrace.

### ESSENTIALS OF A HEALTHFUL HOME.

It may be well, as an introduction to the subject, to state briefly the requirements of, and the conditions which ought to prevail in, a healthful house. Broadly speaking, there should be in and about a habitation *pure air, pure water, and a pure soil*. To enumerate more in particular some of the principal requirements, the house should stand on a dry site, free from moisture or ground exhalations, and should be isolated from

direct contact with the surrounding soil; it should have a light and cheerful aspect, and the surroundings must be in every way unobjectionable; it should be constructed with a view to constant and complete dryness of foundations, walls, and roof; it should have rooms of such a size as to prevent any overcrowding; there should be sufficient ventilation to remove any impurities from respiration, cutaneous perspiration, combustion of fuel, gaseous products of illumination, fumes from cooking, and vapors of steam and soap from the laundry, and noxious odors from plumbing-fixtures; it should have a free admission of pure outer air, of light, and of the sun's invigorating rays during at least a few hours each day. The house must be provided with efficient and unobstructed sewerage, to remove at once all liquid household wastes; and with a good supply of pure and cool water for drinking and cooking purposes, for house-cleaning and laundry purposes, flushing of traps, fixtures, and waste-pipes. Besides, a house should be provided with means for a perfect distribution of an equalized and agreeable

temperature; and with means for artificial lighting without deteriorating the atmosphere of halls and rooms. The protection from the danger of fire should be as complete as it is possible to make it; the removal of garbage and ashes must be prompt and regular, and effected without creating any offence; and there should be throughout the house as little as possible chance for the accumulation of dirt and dust.

“Domestic sanitation,” says Dr. B. W. Richardson, one of the greatest sanitarians, “aims at constructing homes, or improving houses already constructed, so as to remove all defects which may affect health. The essentials for maintaining perfect salubrity in a house are, —

“1. It must present no facilities for holding dust or the poisonous particles of disease.

“2. It must possess every facility for the removal of its impurities as fast as they are produced.

“3. It must be free from damp.

“4. It must be well filled with daylight, from all points that can be charged with light from the sun, without glare.

“ 5. It must be charged with perfectly pure air in steady, changing currents.

“ 6. It must be maintained at an even temperature, and must be free from draughts.

“ 7. It must be charged with an efficient supply of pure and perfectly filtered water.”

### INSPECTION OF CITY HOUSES.

We will begin with city houses. A good deal of ingenuity, coupled with some common-sense and large experience, are required in making a sanitary survey of a house. In making such an inspection, it is well to accept with caution all statements made by others, and to trust only to the observations of your own senses. Of course, some information may be gained by making inquiries, but one should feel certain that the parties conveying the information are entirely disinterested. Before entering a house, take a look at the street. Note its width and general direction, and observe particularly the height of houses on the opposite side of the street; for upon this will,

to a great extent, depend the cheerfulness of your front rooms. Avoid the neighborhood of tall apartment-houses, which rob the street and the houses of sunlight and pure air. Free and airy streets, and plenty of parks and breathing-spaces, are much to be desired in cities. The north side of a street is preferable; for here your front rooms will be sunny and warm in winter, and will enjoy the benefit of the cooling southern breezes in summer-time.

#### INSPECTION OF THE SURROUNDINGS AND OF THE SOIL.

Inquire carefully into the character of the neighborhood, and ascertain if any noisy factories or offensive trades are near by. Avoid the vicinity of slaughter-houses, stables, carpet-beating works, infectious hospitals, and the like. Observe the character and condition of the street pavement, which has more or less bearing upon the salubrity of the street, and note particularly the cleanliness of the gutters. But, above all, look carefully into the character of the building-site. If you can refer to old topographical maps, show-

ing the original water-courses and contours of the land, you will find these a great help in studying this all-important question. If the spot was originally a low, damp site, or a swamp, marsh, or pond, filled up to the street-level, you may at once look upon the site with distrust. It is often a difficult matter to ascertain if such a locality has been well drained before the filling process was begun; and, as regards the material used for filling up the lot, it will hardly be necessary to warn you against the possibility of its being a mixture of ashes, street-sweepings, garbage, rotten vegetation, and house refuse. If you value your health, you should at once abandon the idea of taking a house built on a site which has only recently been filled to the level of the street. Made-land may be rendered available for building-sites after some years; but, of course, even then a *perfect isolation* of the house from the surrounding and underlying soil is required, and to investigate this will be one of your first duties. Even where the soil consists of gravel, sand, or loam, and much more so where it is clay or rock, the matter of drainage—

that is, the removal of subsoil water, or the permanent lowering of the level of the ground water to a good depth below the cellar floor — requires careful attention. If subsoil drains are laid, their location should be ascertained, as well as the manner in which they are constructed, whether of stone or tiles; and particular care should be devoted to their outlet, and to their thorough disconnection from the sewer or house-drain.

#### INSPECTION OF THE CELLAR.

Upon entering a house, it will be well to direct your steps at once to the cellar. If this shows signs of dampness; if the floor is wet, or has pools of stagnant water; if the walls are dripping with moisture, or covered with a mouldy growth, — you may be sure that the house cannot be healthful. Examine with care the construction of the foundation-walls. See whether there is a damp-proof course to prevent the dampness from rising in the walls, whether the walls are coated inside and outside with asphaltum, and whether the wall is built hollow, or is provided with an area

all around to keep off soil-moisture. See whether the walls in the cellar are kept in a proper and cleanly condition, and have recently been white-washed. Note also the depth of the cellar floor below the sidewalk, and the clear height of the cellar. Look for gullies in the cellar floor, and see whether they are left untrapped, or are insufficiently trapped by a bell-trap forming the strainer to the gully, or by siphon-traps with shallow depth of water seal, which is readily lost by evaporation. Examine carefully the condition of the cellar floor. To isolate the house from the earth, the floor should have a layer of concrete at least six inches thick, finished on top with Portland cement, or, better still, with a layer of coal-tar pitch, or asphaltum. Note whether the cellar has ample movable windows for light and air, or a ventilating flue carried along a heated chimney flue.

#### INSPECTION OF THE YARD.

Next go to the yard, and note its size and general condition, whether it is paved and well drained, whether it has a well, a privy in the rear,



or a cesspool; and if so, measure the distances from each other, and from the house foundation-walls. See if the yard is well kept, clean, and free from offensive slops or heaps of garbage. If there is a privy-vault, examine its construction, size, material, ventilation, and see if it is water-tight, and how full. If there is a cesspool, or catch-pit for grease, examine its condition; see especially if it is leaching or tight.

#### INSPECTION OF STRUCTURAL DETAILS.

Returning to the house, it will be well, before taking up in detail the arrangements as to lighting, warming, ventilation, water-supply, and sewerage, to examine the general construction of the house, the material used for building, the character of the roof, the number of floors, the width and depth of the house, and the portion of the lot covered. In this connection it will be worth your while to study somewhat closely the character of the back buildings, and their distance from the rear of the house.

**In** looking into the arrangement of the rooms,

particular attention should be given to the size and clear height of bedrooms, to the number and dimensions of windows, and to the ventilation and lighting of bed-chambers, closets, pantries, and storerooms. As to the walls, it should be remembered that new walls are always damp. In the process of building, an immense quantity of water is put into the walls of a house, which requires much time to be expelled, and which it is much more difficult to expel after a house has been once occupied. Houses, therefore, ought not to be taken for occupancy immediately after the mechanics have left; for a damp house is always unhealthy. As to the inside finish of walls, the best surface, where perfect ventilation is otherwise provided for, would be one that is impervious, non-absorbent, and polished, which could be washed by means of a sponge with clean water and soap. All other surfaces, such as plaster, wood, paint, or varnish absorb more or less organic impurities given off from the human skin. If walls are painted, it is better to varnish them, for then they are much easier cleaned. If the

walls are papered, make sure that the wall-paper contains no poisonous material, such as arsenic. It should be remembered, too, that (contrary to the popular notion that bright *green* colors only may contain arsenic) color is no guaranty whatever as to freedom from arsenic. Arsenic has been detected in often large amounts in dull greens, and equally so in almost all other colors. Nothing but an examination of the individual sample of paper by chemical analysis will decide this question. Another popular fallacy is to presume that the presence of arsenic in colors adds to their brightness. It is now admitted by manufacturers that equally bright-colored papers may be manufactured without it, and this at a cost not greater to the manufacturer. Arsenic detached from flocky wall-papers as dust may frequently be found deposited on the tops of furniture, pictures, doors, etc. But it is also developed and diffused in the air of rooms, as arseniuretted hydrogen, from contact with putrefying starch paste. It is well, even where there is no danger from arsenical poisoning, to ascertain that walls of papered rooms are not

repeatedly covered with succeeding layers of paper, each covering and retaining the organic impurities absorbed by the previous one.

Next inspect the construction of the floors. Well-seasoned wood, free from notches or cracks, should be used. Floors should preferably be constructed of narrow hard-wood boards, laid with close joints, and tongued, so as to prevent the dirt from falling through and accumulating in the closed spaces between the ceiling and the floor, or even lodging in the floor joints; for such organic dust is liable to putrefy, and may often become a source of danger to the purity of the air. For like reasons, floors should be, as much as possible, water-proof. The best floors are hard-wood floors, laid with closely fitting joints, with a smooth surface, well oiled, or waxed, and rubbed and polished.

In going from one floor to the next, the construction and easiness of the staircase should be observed, and notice taken whether the staircase hall is well ventilated and well lighted. See also if there is an ample accommodation on the top

floor for your servants; for you should not tolerate basement bedrooms, which are always unhealthy and stuffy, and generally dark and dreary. See if the roof is tight, and the chimneys above the roof well constructed and in a good condition. It is well to provide parapet walls with impervious coping-stones to prevent dampness from descending into the house-walls.

#### INSPECTION OF THE SEWERAGE AND PLUMBING.

The examination of the sewerage and plumbing of a dwelling should be thorough and minute, for in no other detail of interior construction does "scamping" prevail to such an extent as here; and it is well to fix in your mind, in the preliminary tour of inspection just described, the location of the plumbing-fixtures on the different floors of the house. This will be an excellent guide in following up the course of the various vertical lines of waste and soil pipes, and the location of their junction with the main cellar drain. The detailed inspection of the pipes and fixtures should begin in the cellar.

If the house is old, the main drain is generally out of sight, and often difficult to find, being buried below the cellar floor, and left entirely without means of access. It is absolutely necessary to break up the floor concrete, to dig down to the drain, and to open it, in order to examine its condition. Old houses often have square brick drains, large enough to remove the sewage of a whole village, usually in a bad and dilapidated condition, full of the filth accumulations from sinks and water-closets, and forming a veritable "elongated cesspool" under a house. It need hardly be stated that such a condition renders a house absolutely uninhabitable. An equally bad adjunct of such drains is the so-called mason's trap, often and more appropriately called a cesspool trap, serving to disconnect the house from the sewer, but in reality forming a most disgusting and dangerous cesspool. If the house is of a more recent construction, the main drain may be of cement or terra-cotta pipe. In either case it is usually of far too large a size to keep clean; and, as a rule, it has leaky joints, causing the contami-

nation of the soil under the house, and also accumulations of solid filth, or else stoppages in the pipes. The round running traps used with such drains, to keep off the air from the sewer or cess-pool, are often of defective make or improper shape, and should always be opened and examined as to their freedom from accumulation of sediment and scum. Cement and earthen drains are alike objectionable inside and under habitations. A point at which leakages are very apt to be found is at the junction between vertical soil-pipes with such earthen drains. The drain may have settled, and the contents of the soil-pipe are simply poured, day after day, into the ground; and such condition of affairs, which is by no means unusual in some of the finest city mansions, may have existed for years without having been noticed, thus rendering the soil under the cellar floor a perfect hot-bed for germs of disease. One should make it a rule, in inspecting a house-drain, to make observations regarding the free flow of water through it, by discharging a water-closet, a bath-tub, or other fixture, and thus to gain valu-

able indications as to the inside condition of pipes, which will enable a person to make sure that there are no obstructions, stoppages, or leakages.

In modern town-houses, we find, as a rule, the main drain carried above the floor, of iron, generally alongside one of the foundation-walls. If it is provided with hand-hole fittings or inspection-holes, it is advisable to open these at frequent points, to ascertain definitely the interior condition, and to test the free flow of the house-drain. If the drain has only little fall, or is unnecessarily large in diameter, or is insufficiently supported, and hence presents sags or depressions, and a generally uneven alignment and grade, it will not be free from accumulations. Particular attention should be paid to the pipe-joints, which ought not only to show no signs of leakage of water, but ought to be made so as to remain perfectly and securely air-tight. If the pipe happens to be painted with white lead, a brown discoloration at the upper part of the pipe, near the joint, usually indicates a leakage of sewer air. It should be ascertained if the main drain is trapped or left



untrapped; and if there is a trap, its size and shape must be noted. See also if there is a good-sized air-inlet just inside of the trap, leading to outdoors, to establish a circulation of air in the pipes. Inspect also the location of the air-inlet, note its distance from windows, from the cold-air box of the heating-apparatus; and if it terminates in a box with open grating in the sidewalk, see whether the opening is not obstructed by dirt, or in winter-time by ice or snow. If the trap is accessible, — but it usually is not, although it is important that it should be, — have it opened and examined; and this is a quite convenient point to test the free flow of the soil and waste pipes, and drains. It should be observed, when the trap is placed inside the cellar walls, if the cover of the inspection opening closes air-tight.

Having examined the main drain, all its various branches in the cellar must be spotted out, and carefully scrutinized as to size, material, joints, grade, and manner of connection with the main drain; T-branches always being quite objectionable and inadmissible in good work. Drain-pipes

removing the surface water from front and rear yards and from basement areas must be included in the examination. It is very important to inquire into the method of trapping such wastes, for here evaporation of the water-seal is a frequent occurrence. The removal of rain-water from the roof should also be properly performed. In old houses the soil-pipe is frequently made to do service as a conductor pipe; in which case the danger of siphonage of traps under fixtures is much increased. In houses recently built, the leaders form separate pipes, placed either outside of the house, or sometimes inside of the walls. The method of trapping such leaders must be diligently inquired into, especially if their tops open near attic windows or close to a light-and-air shaft.

Following the examination of the house-drain, the soil-pipe must be traced throughout its whole course, and examined as to its soundness and ventilation; and this inspection is often rendered quite difficult where pipes are hidden from view, as is the case in older houses, where they are commonly built into the walls, and very difficult of access.

Much time is often lost in trying to trace the course of such inaccessible pipes. Soil-pipes of lead prevail in older buildings, and are generally found honeycombed and corroded by foul gases, owing to the utter want of proper ventilation ; for the soil-pipe usually stops at the highest fixture, or has, at best, a small and entirely insufficient vent-pipe extended up to the roof. For this reason it is advisable, in old houses, always to have the soil-pipe completely exposed by tearing up the walls and removing the plastering. Soil-pipes of iron, insufficiently ventilated, are also sometimes honeycombed, and distribute sewer air throughout a house. Moreover, they are, as a rule, defective in the joints. It should be borne in mind that every soil-pipe, and also every waste-pipe stack, ought to be made perfectly air and water tight, and be extended—without any bends if possible—at least full size through, and several feet above, the roof. On going up to the roof, it is easy to ascertain whether or not these conditions have been complied with. It is equally important to make sure that the free outlet above the roof

is not reduced in size, or obstructed by ventilating-caps, return-bends, or cowls. All of these are not only unnecessary, but bad at all times, and positively harmful in winter-time when the top of the soil-pipe clogs through hoar-frost, causing siphonage of traps, or forcing of traps by back-pressure, in houses where the plumbing is otherwise well arranged. This is especially likely to happen if the fresh-air inlet opens in a box in the sidewalk, and has the grating of its opening obstructed or closed by mud and snow. While on the roof, it should also be noted if the soil-pipe terminates near chimney-flues, or shafts of any kind serving for ventilation. It should be ascertained whether the soil-pipe is put together with light or heavy iron pipes, whether it is entirely free from flaws or cracks, and whether the joints are well made and perfectly tight. The same care is, as a matter of course, required in examining vertical lines of waste-pipes. It is of advantage to test the soundness of the whole pipe-system by applying either the smoke test, or the peppermint test, or else a test by means of a force-pump and a pressure-

gauge. The water-pressure test, consisting in filling all pipes up to a certain level with water, valuable as it is for new work, is difficult of application in testing plumbing-work in old houses. I shall not need to enter into a detailed description of the above tests, as they have been sufficiently explained in handbooks of house-drainage: I shall only speak, in a few words, about the peppermint test, which is easily applied by laymen, and the indications of which are exceedingly useful. The extremely pungent, volatile essences of oil of peppermint are well-known to everybody. It is obvious that if such oil of peppermint is introduced into a system of house-drainage, the slightest leak may easily be revealed by the smell escaping into the house. The best place to introduce the peppermint is at the roof; for, if poured into a water-closet or slop-sink at the upper floor of a house, the smell would be too readily diffused from this fixture directly into the house, and thus would interfere with the proper search for leaks. The fresh-air inlet would, in some cases, constitute a handy place for the intro-

duction of the oil ; but in this case all front windows ought to be kept closed during the test. In any case, it is important that the peppermint be not carried much about the house ; and it is absolutely necessary that the helper who pours the oil remains out-of-doors, or at the roof, until the test is concluded, for otherwise he would carry the pungent odor attaching to his clothes into the house. Three or four ounces of pure peppermint oil are quite sufficient, and should be followed up immediately with a few pails of very hot or boiling water. In order to confine the volatile oil in the pipes, it is well to close, during the test, the openings of all soil and waste pipes above the roof. Meanwhile, the inspector or the householder follows up each line of waste and vent pipe, and observes if any smell appears at any fixture, in order to determine, at least approximately, the location of a leak. No fixture should be discharged or used in the house during this test, as the disturbance of the water-level in the trap may liberate some of the smell of peppermint. The smoke test—in which smoke is forced, by

means of a blower, into a house-drain — is superior to the test described, only in so far as it fixes exactly, by the appearance of the smoke, the location of the leak. Other means have been proposed, from time to time, to test the soundness of pipes and traps. It is said that musk, introduced from out-doors into the drains, is readily diffused, and discloses leakages. It is also contended, that, if acetate of lithium or tellurium is passed through soil-pipes, their presence or escape may be detected in the house, by means of the spectroscope, by their characteristic lines. It is evident that such tests, while useful, are not so practical, because requiring the use of delicate and expensive optical instruments.

Having examined the pipe-system, the next step is to inspect the plumbing-fixtures, their waste-pipes, traps, and connections with the main pipes. To do this efficiently and thoroughly, involves the removal of all wood-work about sinks, basins, water-closets, and slop-hoppers. The condition of the enclosed spaces and of the wood-work should be carefully noticed, and will, as a

rule, be found to show much foulness, dirt, and dampness from leakage. The material and particular construction of every plumbing appliance must be inspected in detail. The sizes of waste-pipes and of traps must be noted; and also — although this is a matter of some difficulty — the thickness and weight of the lead pipes. Joints should be closely examined, — those between lead pipes, which should be wiped and not bolted joints; and those between lead and iron pipes, which must be made by means of a brass ferrule.

The servants' water-closet will usually be found in the cellar, and, as a rule, is a sadly neglected corner, rendered foul from spillage, sloppage, leakage, and slovenliness in use, and utterly without means of ventilation. The fixture is, in most cases, a cheap and unsatisfactory hopper-closet, with rough iron surface, rendered foul by an insufficient flush from a supply valve operated automatically by a depression of the seat, or by a pull-up arrangement which is often forgotten by servants. Sometimes the servants' closet is an equally objectionable pan-closet with feeble valve-



flush. The fixtures in the basement are the laundry tubs, the kitchen sink, and possibly a wash-basin. If the laundry tubs are of wood, they often emit a foul smell, due to absorption of organic matter and filth, and present a more or less rotten interior. The trap is usually too large, and probably half-choked with soapsuds and accumulation of sediment. It may not be protected against siphonage, loss of seal by momentum, or back-pressure. In other instances it is entirely absent. The joint of the lead waste-pipe with the main drain is often imperfectly made with putty or cement. Kitchen sinks in older houses are usually trapped by a bell-trap attached to the loose sink-strainer, which is either displaced or lost, thus allowing the free entrance of sewer-air. The kitchen sink often discharges into a large basement grease-trap choked with putrid fat, and always objectionable. The parlor floor seldom contains any other fixtures than a pantry sink near the dining-room, with the usual defects relating to piping, trapping, and ventilation.

The bathroom requires careful search for de-

fects. Not only is the water-closet usually of a bad construction, and defective in workmanship, with an ill-arranged seat, and no ventilation to the apartment, but the wash-basin and the bath-tub have each waste-pipes without traps near the fixtures, the wastes being trapped only by being run into the almost always foul water-closet trap. Besides having long lengths of slimy and foul waste-pipes in direct communication with the room, both fixtures have hidden overflow channels; and, moreover, the almost universal dirty plug and chain arrangement is used. Water-closets situated in the centre of the house ought always to be looked upon with suspicion, unless plenty of ventilation is provided for by artificial means; and if they are fitted up with a "patent disinfecting apparatus," there is all the more reason for distrusting them.

It is astonishing to see what a number of well-educated people commit the blunder of trusting to such worthless devices, which are nothing more than disguisers of the odor, or, at the best, mere stink destroyers. Instead of striking at the root

of the evil, by removing a foul trap or defective water-closet, and by arranging the soil-pipe with a proper circulation of air, much money is uselessly thrown away in buying such "quack" remedies. It is time that the public should know, that, valuable as the sense of smell may be as an indication that something is wrong, it is not so much the smell which causes serious harm. Sewer air may be entirely deprived, by deodorizers or otherwise, of its characteristic odor, and yet be able to cause serious illness. It is far from me to underestimate the value of real disinfection in cases of infectious disease; but true disinfectants must *destroy* the organic impurities and germs of disease, and not merely disguise a bad smell. What we need more than any thing else in our homes, and in particular at our plumbing-fixtures, is cleanliness and pure air. A daily application of hot water, soap, and a scrubbing-brush, a good flush, and plenty of ventilation, are quite sufficient to keep any water-closet or slop-hopper sweet under all ordinary circumstances. If a zymotic disease is in the house, or an epidemic raging in a city,

then it is time for disinfection by strong chemical disinfectants.

As a rule, the separation of the water-closet from the bath is desirable in city houses, unless there are a larger number of bath-rooms connected with dressing-rooms. This does not, however, necessarily imply that the bath and the water-closet should have separate vertical waste-pipes. They may discharge into the same soil-pipe, but preferably through independent outlets. A multiplication of water-closets or other fixtures is not, however, desirable, especially if they would not be constantly used. Urinals are, as a rule, offensive and difficult to clean, and they should not be tolerated at all in private houses. Pan-closets, found even to-day in finer houses, with otherwise good plumbing-work, are generators of sewer air, and in every way an abomination. But, whatever the kind of apparatus used, it should be closely inspected, especially as regards the condition of the wood-work enclosing fixtures, and also as to leakage, trapping, and flushing. The flush should always be derived from a special water-closet cis-

tern, and the inspector should ascertain if the overflow from this cistern is properly arranged. If the water-closet has a trap below the floor, its condition should be noted, and the joint at the floor inspected, which is often leaky, owing to the sagging of the trap. At other times the trap is found to have tipped to one side, thus causing the loss of the water-seal. Safe-pipes from water-closet trays are often found running into the trap of the closet, an arrangement as imperfect as it is dangerous. On the upper floor of a house we often find a slop-sink, usually in a very foul condition, insufficiently trapped, and without ventilation to the usually dark and stuffy closet in which it is placed. It is so often overlooked by builders, that slop-hoppers require a strong flush to keep the sides of the vessel clean, and that they should have a fixed strainer to prevent obstructions.

Of all the fixtures in a house, however, none demand a closer investigation than the "set" wash-basins, located, in city houses, between the front and rear bedrooms. Objectionable as such fixtures are in any case in sleeping-rooms, they

are rendered still more so by the bad planning and arrangement of their waste-pipes. Their traps, usually of much too large calibre, and hence forming miniature cesspools, are easily siphoned, or rendered useless by evaporation or back-pressure, by tipping over, or loss of seal by capillary attraction, caused by hair or lint hanging over the bend of the trap. Their waste-pipes are carried, with rare exceptions, almost horizontally across floors and halls to the soil-pipe, or into the water-closet trap. The space under the basins is tightly boxed up, or, if accessible, is used to hide away all sorts of used-up household articles; and the enclosed space sadly lacks ventilation. It is usually damp, full of dust, or even filthy. Moreover, the leaden tray or "safe," arranged to prevent damage to ceilings caused by leakage or accidental overflow, is provided with an untrapped "drip-pipe"; or, if the latter is trapped, the trap is rendered useless by evaporation. Particular care is necessary wherever such traps are so arranged as to be supplied by small feed-pipes. The latter often stop up through sediment, or fail to work

from some cause or other, and hence should always be considered objectionable as giving a false sense of security. It is only in houses built within the last five years, that we find drip-pipes entirely disconnected from the foul pipe-system of the house. Even then it is advisable to test such drip-pipes, as well as disconnected overflow pipes, by pouring water through them to ascertain their true course, and to locate the outlet of each of them; above all, to make sure against "dummy" pipes. Much the best plan is to do away entirely with safes and safe-wastes; for they form channels of communication between various parts of a house, and often carry offensive odors from the basement or kitchen into bedrooms or bathrooms.

I have not attempted to give an exhaustive list of defects in the drainage or in the plumbing, but have simply called attention to some of the graver mistakes frequently found in even the better class of houses. Amongst other not less serious defects frequently incurred, I may mention: broken drains; drains improperly laid, or without proper foundation, or with fall the wrong way; old cess-

pools under houses, forming a perfect gasometer for poisonous gases and noxious emanations ; badly jointed pipes ; choked pipes and traps ; pipes obstructed by entrance of tree-roots ; junctions made by cutting, roughly, holes into pipes ; bends in drains made with straight pipes instead of with elbow-fittings ; soil-pipes joined to the drain with T-branches instead of curves or Y-branches ; traps placed at the foot of vertical soil or waste pipes ; vent-pipes or soil-pipes run into flues, and often obstructed by soot ; upper ends of soil-pipes stopping below the roof, inside of the house ; lower ends of soil-pipes broken off by drain settling ; house-drains not connected at all with the sewer ; extensions of vent-pipes or soil-pipes through the roof, made with galvanized sheet-iron pipes and loose "slip" joints ; all kinds of by-passes in vented traps, whereby traps are rendered useless, and sewer air finds an exit into rooms ; dummy vent-pipes ; connections between ventilation-pipes at the house side of traps, with soil or vent pipes ; soil-pipes terminating near, or on a level with, ventilating-shafts, chimney-flues, or below dormer



windows ; nails driven into lead soil or vent pipes ; refrigerator wastes having a direct connection with a sewer or drain ; iron soil-pipes full of sand-holes covered with tar or asphalt ; split hubs in iron soil-pipes ; all kind of defective and fraudulent joints ; traps placed at a distance from fixtures ; one trap only used for several fixtures ; the double trapping of fixtures ; traps unsealed by tipping ; reservoir and cesspool traps ; D-traps ; gullies with bell-traps ; untrapped overflow pipes ; waste-pipes with fall the wrong way ; connection of overflow and vent pipes ; sink-pipes choked with grease ; leader pipes used to carry off foul wastes ; untrapped leader pipes opening near upper windows ; defective water-closet apparatus ; concealed or secret waste or overflow arrangements ; and water-tanks placed in improper places, for instance, in the same apartment with the slop-hopper.

It may here be remarked, that the popular notion that "sewer gas" is a specific gas is a fallacy ; and the question often asked by people, how the presence of "sewer gas" may, by some easy test, be detected in a room, is absurd. It should be un-

derstood that there is no such thing as "sewer gas," and what is usually so called should more correctly be named sewer air, for it is simply air more or less contaminated by products of decomposition emanating from foul vessels or fixtures, from sink, waste, and soil pipes; from house-drains; street-sewers, privy-vaults, cesspools, etc. Sewer air, in other words, is an ever-varying mixture of gases; and of those that are deleterious the more prominent are sulphuretted hydrogen, sulphide of ammonium, and carburetted hydrogen; while ammonia, carbonic acid, and occasionally carbonic oxide derived from leakage of illuminating gas into sewers, are present in more or less large proportions. The effects caused by breathing such impure air are nausea, vomiting, a general feeling of discomfort, loss of appetite, sometimes blood-poisoning, and a reduced state of health, which renders the body more prone to attacks of zymotic disease. The real danger consists much more in the dirt and dust, particles of organic matter, and living microscopic organisms (the germs of disease) floating in sewer air, and

causing the outbreak or the spread of some preventable diseases, such as diphtheria, typhoid-fever, cholera, diseases of the bowels, etc. Though the sense of smell occasionally may afford a warning as to the presence of deleterious gases escaping through imperfect pipes and fixtures, yet it should not be relied upon; for invisible poisons, frequently the most dangerous, are often present in our homes.

#### INSPECTION OF THE WATER-SUPPLY.

The water-pipes, faucets, the kitchen-boiler, and water-tank must all be included in the examination of the plumbing-work. See, first, whether the water-supply is constant on all floors of the house; and, should the pressure in the mains be insufficient to accomplish this, see if a cistern and a force-pump of some kind are provided. As to the water-pipes, observe if they are carelessly arranged, unprotected against freezing, or even buried in the wall, rendering it difficult to trace them throughout their whole course. Note if all water-pipes are run with a continuous

grade, so that they may be completely emptied if desired. To accomplish this, there should be a stop and waste cock in the cellar, located near the point where the water-pipe enters the house. Joints in water-pipes, if these are of lead, are often improperly made, and the pipes carelessly run without being well fastened to boards with metal tacks. Joints in brass or iron pipes are often leaky. The kitchen-boiler may also be leaky or patched up, showing that it has previously been bursted, owing probably to a defective arrangement of the hot-water supply system. The tank in the attic requires particular consideration, as the water in it is easily rendered foul by an overflow connection to a soil-pipe, or by drawing the flushing-water for water-closet valves directly from it, instead of using proper waste-preventing cisterns over each closet, supplied from a self-closing ball-cock. A thick mud is frequently found at the bottom of drinking-water tanks: hence, such tanks should always be placed in a position where they are easily got at for cleaning and examination. If it is likely that the water

for drinking or cooking purposes be drawn from the tank in the attic, it should be frequently emptied, and its bottom and sides scrubbed and cleaned. It is important to ascertain if drinking-water tanks are properly lined with tinned copper or slate, and not with lead or galvanized iron. As regards the supply to bath-tubs, this should always be over the top of the tank, and not by a mixing-valve at its bottom. A plan of the house, drawn to scale, and showing in detail all the drains, soil and waste-pipes, service-pipes, stop-cocks, hand-holes, traps, etc., is of course a great aid in making a sanitary house-inspection, but it is very seldom that it is available.

#### INSPECTION OF THE METHOD OF GARBAGE DISPOSAL.

Having completed the examination of the plumbing and drainage, the next point requiring attention is the proper removal of the solid house-refuse, which ought never to be attempted by aid of the sewers and drain-pipes. There should be two distinct receptacles, — one for ashes only, and the other for kitchen offal and garbage. Much

of the latter may be disposed of in a simple, yet efficient manner, by being dried, and burned in the kitchen range. Ashes and garbage ought to be removed from houses by entirely separate scavenger carts. Swill-pails, as well as ash-barrels, should not be of wood, but of galvanized iron, circular in shape, fitted with a well-closing cover, and kept at all times most scrupulously clean.

#### INSPECTION OF THE ARRANGEMENTS FOR WARMING THE HOUSE.

The next step in the inspection is to look into the arrangements for warming the house. Defective heating and ventilating arrangements may be the cause of debility, nervousness, and general loss of strength and health, as well as of pulmonary diseases; and hence it is very important to inquire with care into this matter. The heating-apparatus most usual in city houses is the warm-air furnace, but sometimes we find a steam-heating or a hot-water apparatus used. All these are placed in the cellar of the house, in a central position. Local heating by stoves is common in

smaller houses, or is adopted for minor rooms of larger houses; openings being provided in chimney-flues to receive the stove-pipe, leading smoke and gases of combustion from the stove into the chimney. In the principal rooms of the better class of houses, we also find an auxiliary heating-apparatus; namely, the open fire-place. Stoves, being usually a part of the movable furniture of a household, need not here be considered; and as regards fire-places, the examination may be confined to the arrangement and size of the flues. It should be noted whether the fire-place is of the ordinary kind or one of the improved, so-called ventilating fire-places, in which case the channel for the admission of fresh air should be inspected. Much more important is the detailed examination of the warm-air furnace in the cellar, or the steam-boiler or hot-water apparatus. Note whether the furnace is portable or set in brickwork; whether constructed of wrought-iron, soapstone, cast-iron, or of a combination of wrought and cast iron. Measure the dimensions of the furnace, to get at an approximate estimate of its available radiating

surface. See to it that the furnace is of proper size, so as to heat the house comfortably without being at any time overheated, or delivering too hot air into the rooms. Carefully examine the joints of the furnace (the fewer there are the better), and see if they have not become untight, owing to contraction and expansion of the metal. Look for leaks in the furnace at other places than the joints, and observe the construction of the fire-pot, and whether it is lined properly with fire-brick; for such a lining does good service in preventing excessive overheating of the metal. Next, take a look at the size and run of the smoke-pipe, and note the presence or absence of a damper in it. See also if ample provision is made for the evaporation of water. A mixing arrangement for cold air from the air-chamber, and warm air to regulate at will the temperature of the air entering the rooms through the registers, is very desirable, but seldom applied to warm-air furnace apparatus. Above all, look for the cold-air box. Its absence is a cardinal defect in all central heating-apparatus, as it is positively wrong to take



the air-supply to the living and sleeping rooms from the cellar; for, except in houses where unusual care is taken to ventilate the latter properly, its atmosphere is a mixture of noxious emanations from a filthy cellar closet, of sewer-air passing up from a dried-up gully-trap, assisted by the suction of the house-chimneys, and possibly gases of decay emanating from rotten vegetables or forgotten house-refuse. If there is a cold-air box to the heating-apparatus, see of what material it consists, and how it is constructed and put together. Examine carefully for cracks or imperfect joints. Wooden air-boxes are not to be recommended on this account, besides being dangerous on account of fire. If the cold-air channel is located below the cellar floor, it is advisable to open it to ascertain whether the channel is sufficient in size, smooth, and clean, and unobstructed, and kept perfectly dry. If ground water is liable to rise to near the height of the channel, the cold air should preferably be admitted by a channel situated near the cellar ceiling. All air-boxes form convenient receptacles

for dirt, insects, cobwebs, dust, and organic impurities, and hence ought to be made, if possible, accessible, so as to be cleaned from time to time. Most important of all is the opening of the cold-air box to the outer atmosphere. In city houses it is preferable to locate it at the rear of the house, in order to take the air from the yard, thereby avoiding the dust from the street. The opening should not be near the level of the ground, terminating at a cellar window; nor should it be near any ventilating-pipe for drains, near a yard gully or yard privy, or a cesspool; nor should the ash-barrel, dust-bin, or any accumulation of rubbish be allowed near it. It is preferable to have the inlet placed at least ten feet above the level of the yard; and its opening should always, and especially if only a few feet above the ground, be suitably protected by wire netting against entrance of cats, rats, mice, or vermin. Wherever the air is loaded with street dust or particles of soot or impurities, it may be well to filter the air by means of cotton-wads placed at the entrance of the cold-air box. These, however, require frequent renewal, as they

soon clog, and obstruct the free admission of air. It is also well to have in the cold-air channel a movable slide to regulate the amount of air admitted to the furnace. The size of the channel should be ascertained, and its proportion to the aggregate cross sectional area of all hot-air pipes.

The hot-air flues should next be examined, their size and course, as well as their length and grade, noted; and it should be remembered that horizontal hot-air pipes should not generally exceed from twelve to fifteen feet in length. Since short lengths of horizontal pipes and vertical flues draw much better than long horizontal pipes to the first-floor registers, an even and nearly equal draught in all pipes should be established by means of valves or dampers, and by rightly proportioning the sizes of the various hot-air pipes and flues. Examine the position of the inlets for warm air in the room,—whether located in the floor, in the wall near the bottom or near the ceiling, or at an intermediate height. The size and construction of the register boxes require attention; and, wherever registers are placed in the floor, it is

advisable to remove them, and to examine the interior of the hot-air pipe, which will usually be found to be far from clean. Hot-air flues opening in the floor are always objectionable, because much dirt and dust must of necessity fall into them. In all rooms heated by warm-air flues, look for and examine the outlets provided for removal of impure air; for no central heating-apparatus will work well unless both inlets as well as outlets are provided.

In the case of houses heated by low-pressure steam-heating apparatus, it is important to examine whether the heating is accomplished wholly or partly by direct radiation (that is, by having heating surfaces, pipe or box coils, placed in the rooms to be warmed); or by indirect radiation, in which case coils of pipe are placed at the cellar ceiling, as nearly as possible directly under the rooms to be warmed, and fresh air led by cold-air boxes from the outside to such coils, where it is warmed to the requisite temperature. The latter is sometimes regulated by having a number of steam coils, into each of which steam may be turned, and which can

be shut off in sections at pleasure by means of valves. From here the warmed air is delivered to the rooms by means of hot-air flues in all respects similar to those used for furnace-heating. With radiators placed in the rooms, steam-pipes must be carried to the upper floors, sometimes all over a house. The size and construction of the radiators, and of the pipes supplying them with steam, should in this case be examined; the coils should be free from dust; search ought to be made for leaky joints and valves, and particular attention paid to the question of fresh-air supply. If air is admitted from the outside, and warmed at the radiators, which are then usually placed in the window recesses, the system is the so-called direct-indirect radiation; and the channel for fresh air should be examined, its size noted, and its opening to the outer air inspected to make sure that it may not draw its supply from impure sources. It is important, for sanitary reasons as well as for the sake of economy in the use of steam, to have all steam-pipes in the cellar properly covered with some good non-conducting material. This is, moreover,

a very necessary precaution against fire in all cases where steam-pipes pass close to woodwork.

The close and detailed inspection of the steam-boiler is very important; but it is a matter requiring skill, knowledge of the mechanical construction of the apparatus, and experience in the use and application of steam and the combustion of fuel, and it is recommended to call in the aid of an expert in boiler-construction and boiler-management. This inspector should ascertain, by inspection and hammer-test, that the boiler is properly constructed, that it has no weak place, and that it is kept in a good condition, free from corrosion, from incrustations, sediment, and dirt or other defects. If necessary, the boiler should be tested by forcing in water under a heavy pressure. It should be noted if all joints and packings are tight; if the feeding-apparatus, if such is used, is in proper working order; if all trimmings and appendages are complete; especially if the gauge-cocks and glass gauges are working easily, and the steam-gauge and safety-valve are kept clean, and working regularly and easily. Examine all pipes

and cocks with care, to ascertain that they are not in any way obstructed; examine also the draught-regulator, the fire-box, the grate and ash-pan, the smoke-flues and dampers,—all of which should be swept, or kept free from soot, slag, or ashes. Brass trimmings ought to be kept bright and polished. No cotton-waste or oil rags should be lying around the boiler, as they may cause fire by spontaneous combustion. The floor and walls around the boiler ought to be kept neat and clean, and free from standing water. Persons living in a house fitted up with a steam-heating boiler should remember, that, to prevent accidents or danger to property and life, it is safest and best to have a *periodical* inspection of it made, at least once a year, to ascertain if the boiler may be used with safety. Particular care should be taken with steam-heating boilers, if they are put out of use during the spring and summer, to prevent corrosion of the boiler or any of its parts. This may be accomplished either by keeping the boiler filled with water, or, better still, by nearly filling it with water, then adding to it a few gallons of pure

mineral oil so as to quite fill the boiler, and then drawing off the water, whereby all the interior surfaces of the boiler will come in contact with the oil. Thus oiled, the boiler should be kept perfectly dry and closed, until the fire is again started in the fall of the year.

Similar hints and cautions might be given with regard to hot-water apparatus; but inasmuch as this is not usually adopted in city houses of average size, although possessing some advantages over a steam-heating apparatus, we will be content with a mere mention of the apparatus.

#### INSPECTION OF THE GAS-LIGHTING ARRANGEMENTS.

The next subject of inquiry should be the means arranged for lighting the house with illuminating-gas. This is conveyed to the building under pressure, by a main gas-pipe, and distributed throughout the house by a network of small wrought-iron service-pipes, put together with screw-joints and suitable malleable-iron fittings. To get at an idea of the distribution of sizes of gas-pipes in a finished house is generally



utterly impossible, owing to the universal habit of burying all gas-pipes in walls, in partitions, and between floor-joists: yet the illumination of the house will to a great extent depend upon a proper arrangement of the pipe system; pipes of too small calibre being objectionable, and frequently choking up and causing the flow of gas to be perceptibly obstructed. All pipes should be run with a slight continuous fall towards the meter, to avoid anywhere in the system a depression which would accumulate water, and cause the trapping of the pipes. Wherever a gas-pipe passes from a warm room into one of much colder temperature, it may be well to arrange a pocket with movable plug to enable the removal of water from condensation. As to the gas-meter, see if it is set perfectly level, and located in a cool place in the cellar; for changes of temperature will cause a given quantity of gas to occupy different space, hence may affect the correct registering of the gas-meter. It is equally important that freezing of the meter be prevented; as otherwise constant annoyances, and even serious trouble, may occur in winter-time. I

may here remark, that a gas-meter, measuring the volume of gas burned during a given time, is not, in reality, a just measuring apparatus by which to regulate the total cost of the gas consumed ; for, strictly, the price of gas should be fixed according to its specific weight, and, above all, according to its candle-power.

Not infrequently defects in the gas-piping, seams, flaws, or pin-holes in pipes, leaky joints, bad fittings, or defective gas-fixtures, exist in houses ; and slight, and sometimes imperceptible, leakages, more commonly than most people would imagine, either at burners or at joints, contribute a share to the constant contamination of the air in city houses. For a slight and scarcely perceptible escape of the gas causes a peculiar smell, quite unlike the well-known, strong, and pungent odor of coal-gas. Since illuminating-gas contains a number of hurtful elements, especially carbonic oxide, the inhaling of such air, polluted by slight but constant leakage, is very injurious to health. If larger quantities of gas escape, and mix with the air in rooms, they bring with them the danger

of explosions, not to mention the annoyance of exorbitant gas-bills. If a decided smell of gas is apparent, or a large leak suspected anywhere, search should never be made for it with a lamp or candle, to avoid the danger of an explosion. The first thing to do is to shut off the gas at the meter; then to open all windows, particularly the upper sash; and then to search for the leak. Likewise, gas-meters should never be inspected or examined after dark, by lighting a match or otherwise.

It is always well, before entering upon occupancy of a house, to have the gas pipes and fixtures carefully tested. A very simple way of ascertaining if leakage of coal-gas is going on is to make sure that no lights are burning, and to watch the small index-hand of the gas-meter for several succeeding hours. This can be readily done, even by laymen. Another method is to fix to a burner a water-gauge, a glass tube with legs at least three inches long, bent in the shape of the letter U, half filled with water. The cock of the burner should be turned on, when the difference

of water-level in both legs will indicate the pressure of gas in the pipes. The gas should then be turned off at the meter; and, if the water in the gauge now remains steady, the pipes and fittings are tight; but, should it slowly descend until it again stands level in both legs, there is a leak somewhere. Of course it is important to know that the main cock at the meter shuts perfectly tight, and this should be tested independently.

The best test of the gas-piping is by means of a gasfitter's pump and a mercury-gauge. To locate a leak, sulphuric ether is sometimes used; but as the sense of smell is inferior to the sense of sight, in exactly locating a leakage, it is better to apply soapsuds to the joints, when a leak will be readily indicated by soap-bubbles. To do this in a finished house, requires, of course, first the locating of a leak at least approximately, so as to avoid the tearing up of too many floor-boards, or the cutting of plaster, or removal of expensive wall-papers.

Even with a perfectly tight system of gas-piping and gas-burners, the atmosphere is contaminated

by the combustion of the gas. If this combustion be perfect, and the gas furnished perfectly purified, the only products would be carbonic acid and water; and if, by ceiling ventilation and by the aid of the heat of the gas-flames, the removal of both is provided for, no evil results may be apprehended. But, for various reasons, the combustion of gas-flames is usually quite incomplete, and the gas often but imperfectly purified; and hence injurious gases, compounds of sulphur and of ammonia, besides carbonic oxide, escape into the room. This explains why so many complaints are often made as to the disadvantages of gas-lighting,—amongst them that the air becomes loaded with noxious vapors, injurious to the human constitution; and that gas-light causes damage to books, pictures, furniture; and that heat is produced out of all proportion to the illumination.

It should be borne in mind, that the intensity of the light obtained depends not so much upon the quantity of gas consumed as upon the conditions under which it is burned. It is stated by good authorities, that, of all the gas passing a meter,

from thirty to fifty per cent is not infrequently wasted by imperfect combustion. As chief causes of this waste may be taken an excessive pressure at the burners, bad burners, and unsuitable arrangements of glass globes and fittings. In inspecting a house, it should therefore be noted if it is located on high ground; and, if possible, the pressure of gas on the house side of the meter should be ascertained. The greatest amount of light from a given quantity of gas would be obtained if the flow of gas at the burner, and the flow of air to the flame, are slow, regular, steady, and uniform; the pressure at the burner being moderate, and not exceeding six-tenths of an inch of water-pressure. If, on the other hand, gas rushes from the burner, generally with a whizzing noise, under a high pressure, it mixes quickly with the air, and passes in an unconsumed state into the room; the light is unsteady and flickering; the flame jumps on account of unequal pressure; and the illumination is bad, because not all the carbon has time to become incandescent. The air-supply being insufficient, smoke is pro-

duced, and blackens ceilings or walls, and the air is contaminated. If a single flame is kept burning at night, the turning-off of a large number of flames in a district may suddenly increase the pressure at the burner so much that the flame jumps up very high, and may even set things on fire. Since the pressure of gas in the mains necessarily varies much at different times, and is almost always in cities in excess of what is required for economical and efficient illumination, it is advisable to regulate it by pressure governors or regulators, placed at the house side of the gas-meter. Even if no other results would be accomplished, the prevention of frequent breakage of glass globes and the saving of gas are important considerations. From a sanitary point of view, the better illumination, and the prevention of air-contamination from unconsumed gas passing through the burners, are of course to be more highly appreciated.

Next in importance to the regulation of the gas-pressure is the choice of burners of suitable material, shape, and construction. The inspection

should ascertain if the burners have metallic or lava tips; the former being objectionable, because they rapidly corrode, besides abstracting much heat from the flame, owing to metal being a good conductor. Lava tips, too, may become obstructed, and thus will cause a diminution of the illuminating power of the light. It should be ascertained what kind of burners are provided, whether single-jet, fish-tail, or bat-wing burners. In the case of high flats, it may be advisable to use governor-burners in place of a governor at the meter in the cellar. Finally, the size and shape of the glass globes should be noted, since globes with narrow opening at the base do not admit sufficient air at a low velocity to insure a steady flame and a good illumination.

#### INSPECTION OF THE VENTILATION OF THE HOUSE.

Not the least important subject of inquiry is the ventilation of the house. The air in habitations is deteriorated (1) by a decrease in the amount of oxygen, by the breathing process of persons, and by artificial lighting; (2) by an increase of



carbonic acid and watery vapor; (3) by an increase of offensive particles, liberated by cutaneous perspiration; (4) by inorganic dust from outside and from inside, ashes from heating-apparatus, etc.; (5) by vegetable and animal organic and mineral floating impurities; (6) by carbonic oxide from cracks and leaky joints of the heating-apparatus.

Constant admission of pure air, and removal of foul air, are important everywhere, but nowhere more so than in the bedrooms, bathrooms, water-closet and slop-sink apartments; in the staircase hall; in pantries, larders, store-closets, where often a faint and musty odor may be detected; in the closet for soiled linen; in the tank-room; in the laundry, where vapors of steam and soapsuds, mixed with particles of organic filth from soiled linen, contaminate the air; in the kitchen, where odors from cooking, and the excessive heat of the range, often render existence intolerable; and in the cellar, for cellar air is liable to rise, and to pervade the whole house.

In questions of ventilation, it is well to remember, that, to quote Charles Kingsley, —

“Those who habitually take in fresh breath will probably grow up large, strong, cheerful, active, clear-headed, fit for their work. Those who habitually take in the breath which has been breathed out by themselves, or any other living creature, will certainly grow up, if they grow up at all, small, weak, nervous, depressed, unfit for work, and tempted continually to resort to stimulants, and become drunkards.”

The unwholesomeness of house-air cannot always be indicated by offensive odors, since deleterious elements of air possess neither a very decided nor always an unpleasant odor. It is well known that air which may carry with it fatal germs of disease may be entirely devoid of smell. Fire-places in all living and the principal bed rooms form a great aid in house ventilation, removing a large part of the air fouled by respiration and perspiration; and therefore the throats of fire-places should always be kept entirely open. It should be noted, in inspecting a house, whether ceiling-ventilators are provided, which are desirable to remove the heated air contaminated by the combustion from gas-

burners, as well as hot, foul air rising to the ceiling in case rooms are crowded with guests. Fresh air should be admitted in ample quantity during the cold months, in connection with the heating-apparatus, either by means of cold-air chambers leading to the heating-apparatus in the cellar, or by cold-air ducts leading to the warm-air chamber of the ventilating fire-place in the room, or to coils of hot water or steam-radiators in rooms. It is necessary to add a sufficient amount of moisture to air heated by furnaces, steam, or hot-water coils. It is of the greatest importance to note if the pure air admitted is adequately and thoroughly distributed in gentle currents without creating dangerous draughts, and properly diffused throughout the whole space of an apartment. Even with ample provision for air-supply and foul-air removal, it sometimes happens that currents of pure air take a nearly straight course directly to the foul-air outlets, without being diffused in the space to be ventilated. It is well, therefore, to pay attention, in examining the ventilation of a building, to the probable movement of air-currents in rooms.

In the case of water-closet apartments, the provision for a well-drawing outlet-flue to remove gases is more important than a pure-air supply, which will readily flow in from halls or adjoining rooms. If necessary, recourse should be had to gas-burners arranged in outlet-flues. A kitchen must never be without a large ventilating-flue, and the cooking-range must have a suitable hood connected with it.

A detailed examination of the sufficiency of a system of ventilation would include the measurement of cubic space available for each person, and of the total volume of air supplied to a room per hour; also the measurement of the size and position of the inlet and outlet flues. Besides this, it would be necessary to note the temperature in various parts and heights of each room, to measure the degree of humidity of the air, and the purity of the air, not merely by the senses, although the indications given are also valuable, but also by chemical and microscopical analysis. Such an extended investigation is, fortunately, seldom required in the case of private houses,

although it may be very important in the case of public buildings. The sense of smell affords a good indication of the amount of ventilation in a room, on entering it from out-doors ; yet it cannot always be relied upon, and simple methods for determining the amount of carbonic-acid impurity are always preferable. Such tests are readily performed, and may be of service, inasmuch as the carbonic-acid impurity, while not in itself an indication of danger in the amounts found present in rooms, is a valuable indicator of the organic impurities in air fouled by respiration.

A simple and handy apparatus for quickly making a qualitative test of the purity of air is the pocket apparatus designed by Professor Wolpert. It consists essentially of a glass test-tube with white bottom, and sighting-mark on the latter, and of an india-rubber bulb with glass tube attached, of a certain fixed capacity. The bulb is filled, by repeated squeezing, with air of the room ; while the test-tube is filled, up to a certain index-mark, with clear lime-water. The glass tube of the rubber bulb is then inserted into the

test-tube, and all the air squeezed out by a gentle pressure, and made to pass through the lime-water. This operation is repeated until a marked turbidity of the lime-water is apparent, and the sight-mark at the bottom of the test-tube disappears. The number of squeezes of the rubber bulb should be counted; and, by referring to a small printed table accompanying the instrument, the corresponding amount of carbonic-acid impurity in the air is readily ascertained. For instance, if fifty squeezes should be required, this would indicate the amount of carbonic acid to be 4 parts per 10,000 parts; in other words, the air would be about normal. If thirty squeezes are required, this corresponds to 6.6 parts of carbonic acid, or about the limit of allowable impurity in rooms. Twenty squeezes would indicate 10 parts carbonic acid per 10,000 volumes of air, and so on. The test is readily accomplished by anybody, and gives sufficiently accurate information to enable a person to judge of the character of the air in a room.

Let no householder, who values the health of

his family, underestimate the importance of house-ventilation. To the frequent question, "Why make all this fuss about ventilation? Our forefathers got on very well without it," Charles Kingsley, in his lecture, "The Two Breaths," answers:—

"Our ancestors did nothing of the kind. Our ancestors got on usually very ill in these matters; and when they got on well it was because they had good ventilation in spite of themselves. First, they got on very ill. To quote a few remarkable cases of longevity, or to tell that men were larger and stronger on the average in old times, is to yield to the old fallacy of fancying that savages were peculiarly healthy, because those who were seen were active and strong. The simple answer is, that the strong alone survived, while the majority died from the severity of training. Savages do not increase in number, and our ancestors increased but very slowly for many centuries. I am not going to disgust my audience with statistics of disease; but knowing something, as I happen to do, of the social state and of the health of the Middle Ages, I have no hesitation in saying

that the average of disease and death was greater than it is now. Epidemics of many kinds—typhus, ague, plague, all diseases which were caused more or less by bad air—devastated this land and Europe in those days with a horrible intensity, to which even the choleras of our times are mild. The back streets, the hospitals, the jails, the barracks, the camps,—every place in which any large number of persons congregated,—were so many nests of pestilence engendered by uncleanness, which defiled alike the water which was drunk, and the air which was breathed. And as a single fact, of which the tables of insurance companies assure us, the average of human life in England has increased twenty-five per cent since the reign of George I., owing simply to our more rational and cleanly habits of life.

“ But secondly I said, that, when our ancestors got on well, they did so because they got ventilation in spite of themselves. Luckily for them, their houses were ill-built, their doors and windows would not shut. They had lattice-windowed houses too, to live in ; one of which, as I can testify from



long experience, is as thoroughly ventilating as living in a lantern with the glass broken out. It was because their houses were full of draughts, and still more, in the early Middle Ages, because they had no glass, and stopped out the air only by a shutter at night, that they sought for shelter rather than for fresh air, of which they sometimes had too much ; and, to escape the wind, built their houses in holes, such as that in which the old city of Winchester stands. Shelter, I believe, as much as the desire to be near fish in Lent, and to occupy the rich soil of the valleys, made the monks of old England choose the river-banks for the sites of their abbeys. They made a mistake therein, which, like most mistakes, did not go unpunished. These low situations, especially while the forests were yet thick on the hills around, were the perennial haunts of fever and ague, produced by subtle vegetable poisons, carried in the carbonic acid given off by rotten vegetation. So there again they fell in with man's old enemy, bad air. Still, as long as the doors and windows did not shut, some free circulation of air remained. But now our doors and

windows shut only too tight. We have plate glass instead of lattices; and we have replaced the draughty and smoky, but really wholesome, open chimney, with its wide corners and settles, by narrow registers and even by stoves. We have done all we can, in fact, to seal ourselves up hermetically from the outer air, and to breathe our own breaths over and over again; and we pay the penalty of it in a thousand ways unknown to our ancestors, through whose rooms all the winds of heaven whistled, and who were glad enough to shelter themselves from draughts in the sitting-room by the high screen round the fire, and in the sleeping-room by the thick curtains of the four-post bedstead, which is now rapidly disappearing before a higher civilization. We, therefore, absolutely require to make for ourselves the very ventilation from which our ancestors tried to escape."

#### BAD ODORS AND PREVENTION OF DUST.

If the air in a house is defiled by bad odors, the trouble is usually ascribed to the drains; but

it sometimes happens that such smells cannot be traced either to defective plumbing or to bad arrangement of the warm-air furnace, or to a leak in the gas-pipes. Decaying organic matters, particularly dead animals, either mice or rats hidden under floors, are at times found to be the cause of the trouble. Foul air is often found to make itself unpleasantly felt in places entirely remote from its source. It travels along rat-runs under cellar-floors, in the hollow spaces between floors and ceilings, behind wainscoting or panelling, along the air-spaces in hollow partitions, or in the hollow flues of furred brick walls. All such channels should be closed at each floor, to prevent not only the distribution of bad smells, but also to avoid a dangerous spreading of smoke and fire. Drip-pipes form another ready channel of communication between the remotest parts of the house. Speaking-tubes are likewise the cause of such trouble, and it is even said that the tubes enclosing bell-wires at times lead foul air from one floor to another. The search for the origin of such bad smells is often a puzzle, even to those experienced in such investigations.

Intimately connected with the subject of dwelling-house ventilation is the prevention of dirt and dust. Heavy flock-papers, hangings, *portières*, curtains, carpets, collect dust, and absorb unhealthy impurities from the air. But they belong rather to the furnishing of a house; and, while it is possible and advisable to pay some attention to a healthful decoration and furniture of houses, it is a subject which does not properly come under sanitary house-inspection. The latter will have to deal only with whatever stationary or fixed furniture a house for sale or to rent contains. It is not unusual to provide rooms with cupboards or wardrobes having sunken tops and mouldings, on which a large amount of floating dust collects, and generally remains there for months, except so far as it is disturbed by draughts, whereby it is mixed with the atmosphere of the room, and helps to make it stuffy and unwholesome, or settles down upon the furniture of the room, and upon curtains, bedding, carpets, etc. There is a very simple and efficient way of preventing this by having all cupboards, wardrobes, or fixed book-

cases, buffets, etc., carried up clear to the ceiling, and also quite down to the floor-line. This does not at all exclude a proper and artistical designing and construction of such fixed furniture. It is of great importance that some attention should be paid in every household to this matter.

#### INSPECTION OF THE ARRANGEMENTS INSURING SAFETY AGAINST FIRE.

Having finished the inspection of the important subjects of plumbing, drainage, heating, lighting, and ventilation, there is only one other question requiring consideration ; and that is the safety of a house from, and the precautions taken in a house against, fire. As regards, first, the proper and safe construction of a house, it is generally a matter of great difficulty to ascertain definitely facts bearing upon this point. In a stone or brick house, the hollow spaces usually left between the wall and the furring act as flues, which will rapidly carry the flames from one floor to another. This may be prevented by closing the flues at each floor with bricks and mortar by so-called "fire-

stops ;” and in an inspection this point should not be overlooked. Interior hollow partition-walls may be similarly protected.

As far as possible, the construction of the chimneys should be inspected. Defective flues, cracks in the masonry of smoke-flues (allowing sparks to come in contact with the furring of chimneys), floor-joists built into the chimney, badly pargeted flues, or woodwork carried too near a flue, are often causes of fires in dwelling-houses. See that the smoke-flue of the cooking-range has at least eight inches of brickwork.

The heating-apparatus being a frequent cause of fires; it should be closely inspected, not merely as regards its sanitary and mechanical features, but also as regards its safe arrangement. Smoke-flues for furnaces and steam-boilers should have at least a thickness of eight inches. It is best, however, to line them inside with round glazed earthen pipes. The hot-air flues and the smoke-pipe should never come into close contact with woodwork. See that there is at least six inches of space between any floor-joists, beams, or partition-

studs and a hot-air flue, or the top of a hot-air furnace or a steam-boiler; and see to it that all woodwork in closer contact with hot-air flues or steam-pipes is well protected by a lining of bright tin. It is preferable to have the cold-air box constructed of galvanized iron, to obviate all danger from fire in case the movement of air-currents should be reversed, passing from the register down to the furnace, and out at the cold-air inlet. Care is required in the proper carrying of stove-pipes across and through partitions. Inspect, if possible, the method used in carrying vertical hot-air flues in wooden partitions. Here, too, all woodwork ought to be lined and protected by metal, and kept at a distance of at least three inches from the flues. Note if wire-lathing has been used in such places, for this adds greatly to the security of a house against conflagration. Observe if hot-air flues, in passing through floors or stud partitions, are incased by a large pipe-collar, and if the register-boxes are suitably set. As to gas-fixtures, note if they are kept at a sufficient distance from all woodwork and from ceil-

ings; and wherever bracket lights are used, see to it that they are at a safe distance from curtains, or any other combustible hangings or furniture.

### APARTMENT-HOUSES.

Within the last ten years a new class of buildings has sprung up in some of our largest cities, in New-York City more than elsewhere, chiefly owing to the increased value of real estate in the lower part of the city. These buildings are planned and built so that a more or less large number of families may occupy the different floors of the same house. While such so-called "French flats" or apartment-houses, cannot well be considered as "homes" in the true meaning of the word, yet they are often chosen by many in preference to houses; indeed, many people of small means—the upper forty thousand, to borrow an expression from Mrs. H. M. Plunkett's "Household Sanitation"—are from sheer necessity, owing to the high rates of house-rent, obliged in the largest cities to live in them, if they desire to remain at all



in the city. It is difficult to say any words of praise about them from a health point of view. Even the best of such structures, in the writer's opinion, are but poor apologies for a home. They are often overcrowded, generally ill-ventilated, and afford little of the privacy of even the smallest rural cottage. The light-and-air shafts, the staircase halls, the dumb-waiters, but especially the waste-pipes, unless of a superior character of workmanship, would seem to offer increased dangers to health, and to afford ready channels for the spread of zymotic diseases.

In view of the possibility of an outbreak of fire, it is particularly dangerous to live on the uppermost floors, which are difficult to reach by the streams of a fire-engine. Add to this the well-known fact, that, of all the apartment-houses advertised and rented as "fire-proof," but very few structures are actually built with any regard towards safety, and so as to confine a conflagration to the apartment in which it originates: that, on the contrary, the ventilating-shafts, staircase, elevator and dumb-waiter shafts, form the readiest means

of spreading a fire with rapidity from the basement to the roof; while the not infrequent, but much to be condemned, construction of a stairway surrounding the elevator, and enclosed in the same shaft with it, entirely cuts off the principal means of escape, by smoke, even in case the flames should not have reached the shaft.

There are other reasons, however, why flats, and in particular tall structures, having from five to twelve stories, are objectionable. They exclude to a great extent light and air from the streets below and from the adjacent houses. The interior of city houses, already dark in many cases, owing to the inconvenient subdivision of the city lots, is rendered still more gloomy and unhealthy by these lofty structures; while the street is kept continually damp, and deprived of the greatest means of purification, — sunlight and pure-air currents. There is also danger to life, as well as to the structures of adjacent property, from the falling of high walls in case of a fire. Hence, a due regard for the equal rights of property-holders calls for a decided condemnation of an unlimited height of apartment-houses.

But, even if apartment-houses are properly limited to a height equal to about the width of the street, the system as a whole ought to be condemned, as being opposed to all domestic interests; as endangering, in many cases, the domestic peace and happiness; as robbing the sense and feeling of privacy in a house; as rendering the education of children more difficult; and as weakening, more or less, the feeling of domestic comfort and the family ties. Rooms in flats are seldom arranged with any regard to privacy of the members of a household, nor so that the noise of one tenant may not seriously inconvenience and disturb the peace of mind of his more quiet neighbors. Aside from such moral and social dangers, there are dangers to health which ought not to be disregarded. It is quite obvious, and needs scarcely a further explanation, that, in a building containing many people crowded together upon a small area, the air is more easily befouled than in houses occupied by only a single household. In flats, one family must sometimes undergo discomforts, or even sufferings, owing to the

unsanitary conditions of the rooms of other people in the building. Ventilation is most imperfect or entirely lacking, and tainted air readily passes from one floor to an adjoining or an upper floor. In case of a sudden outbreak of typhoid-fever, cholera, scarlet-fever, diphtheria, or measles, isolation is quite difficult; and the disease is much more easily spread from one person to another, or from one household to another, particularly if carelessness or negligence prevails.

Our remarks refer particularly to American apartments; for, although flats are also common in European cities, they are never to be found there with dark and unhealthy bedrooms, the back windows always being located around a large court or even garden, with ornamental shrubbery, and possibly a decorative fountain.

In the sanitary inspection of apartment-houses, all the hints given with regard to city houses should be borne in mind and observed, as well as much of what will in the following be said about light and ventilation shafts in connection with tenement-houses.

## INSPECTION OF TENEMENT-HOUSES.

From the apartment-house to the tenement-house it is but a gradual step ; and, although what is true of the former holds good to even a greater extent of the latter, yet tenement-houses constitute, and will continue to do so, for many workmen the only places in cities which they can choose to live in, — chiefly owing to the necessity of living near their factories or working places. While we do not propose to speak at length about the necessity of tenement-house inspection, and improvement of the construction and condition of such structures, a few hints on the subject will not be out of place.

The inquiry should embrace the following main points ; viz., general construction, light and air, floor and cubic space, general cleanliness, freedom from dampness, drainage, condition of cellars, garbage removal, water-supply, heating and ventilation, and personal safety.

See whether the tenement is single or double ; note the number of floors, and number of families

on each floor, also the number of people constituting each family. Ascertain, if possible, when the building was erected, and look at the general appearance of the house-front; also note the kind of materials used in construction. Measure width and depth of the main building, as well as the size of the lot; and note the percentage of the lot covered, also the distance from rear buildings. Note whether the basement rooms are occupied as living or sleeping rooms, whether any animals are kept on the premises, and whether any trade or business is carried on in the rooms. If this is the case, it is proper to inquire carefully into the kind of manufacturing process carried on, into the raw materials used, and into the inoffensiveness of the products manufactured. Examine with care the condition of the cellar, especially as regards dampness, drainage, condition of walls, light, air, and what use is made of the cellar. Look also for water-closets in the cellar. In going up-stairs, observe the state of cleanliness of entries, passages, stairs, and halls; and see if they are sufficiently lighted in daytime, and how they are lighted

at night, and what means, if any, are provided for ventilating the halls. Examine particularly the means for lighting and ventilating all inside rooms. Measure the dimensions of each room; note its cubic contents, its clear height, and the amount of window surface, especially of bedrooms. Measure the sizes and areas of all light-and-air shafts; and see if indoor water-closets have special shafts carried to the roof, which ought not to be used to ventilate any living-rooms. See if all these air-shafts have proper communication with the outer air at the top as well as at the bottom. Examine the roof as to construction and material, and see if it is kept in good repair, and gutters and leaders in proper condition, and unobstructed. Note also the appearance of the chimney-tops above the roof; and observe if all soil and waste-pipes are carried at least four inches diameter well above the roof, preferably to such a height that mischievous persons cannot cause their obstruction. Notice also if the outlets are large and free, or have the objectionable return-bend, or a ventilating-cap.

Observe, next, if the tenement has properly constructed fire-escapes; if the stairs are well constructed, and provided with strong railings; and if the roof can be conveniently reached. Examine the provisions made for an ample supply of water on each floor. Note the condition of faucets, pumps, hydrants, and fixtures. Where water does not rise to the upper floors in daytime, see if a tank and force-pump are duly provided and duly operated. Observe the construction, material, and condition of the tank, and look to the disposal of its overflow-pipe. Examine all the plumbing carefully and thoroughly; above all, the construction and condition of the water-closets, the efficient trapping of the sink and washtubs in the kitchen or living-room, and the proper ventilation of the apartments where plumbing-fixtures are located. Consider also the arrangements for heating and ventilating the rooms. Examine the rear yard as to cleanliness, paving, drainage, freedom from odors; and if there are privy-vaults or school-sinks, observe if they are not full and overflowing, but kept in good order, neat, and unobjectionable in



every respect. Finally, inquire into the proper garbage removal by separate closed receptacles, one for ashes and another for the kitchen refuse.

### INSPECTION OF COUNTRY HOUSES.

We will pass over now to the consideration of country houses. These may be subdivided into (1) suburban residences and (2) summer residences, — the former occupied all the year round by people doing business in the city, who wisely care more for the health of their growing children than for entertainments which they must forego if living “out-of-town,” and who prefer a rural or suburban home to narrow and unventilated apartments, or dark and unsanitary city houses; the latter owned or leased by people who go to the country in search of pure air, to avoid the influence of unsanitary surroundings in the city, or who seek refuge at a country-seat on the mountains or at the seaside for at least several months each year, from the summer’s scorching heat, from dusty streets, heated pavements, and

the stifling and smoky atmosphere of a city. The sanitary inspection of both classes of houses and of their surroundings will not differ materially.

#### HEALTHFULNESS OF TOWN AND COUNTRY HOUSES COMPARED.

While there are certain undeniable charms and general advantages of rural life as compared with life in cities, yet it is equally true that the mere fact of living in the country tends, with many people, to create a false sense of security; for in rural not less than in urban districts may be found certain forms of "filth," due to neglect and disregard of sanitary precautions, which may become fruitful causes of infection and preventable disease. While *air* rendered impure by all kind of noxious exhalations, by smoke, street dung, and other volatile, injurious matters, may be looked upon as the prominent factor causing sickness in cities, we find in the country a greater danger from a contamination of the *soil* and of the *drinking-water*. Nevertheless, even in the country the atmosphere in the vicinity of houses, and air

entering these through doors and windows and air-inlets to heating-apparatus, may be contaminated, if no regard is paid to the proper disposal of waste matters from the household. The removal of sewage from habitations, the introduction of a pure and never-ceasing supply of water for domestic purposes, and the removal of ashes and garbage, are sanitary measures carried out in cities by the public authorities; and the householder may restrict his attention, so far as his dwelling is concerned, to the purity of the supply of air,—in other words, chiefly to the heating-apparatus, the arrangements for ventilation, and the plumbing-work. In the country, on the other hand, his care and exertion should be principally devoted to the sources of drinking-water,—the well, cistern, spring, pond, or lake, as the case may be,—and to the means of removing, and disposing of, the waste matters from the house: therefore, sink-pipes, drains, cesspools, vaults, privies, and manure-heaps are the subjects requiring particular attention to maintain a locality in a perfectly salubrious condition.

## CHOICE OF A SITE.

It is an old saying, that, in choosing a residence, one should inquire of some person who formerly lived in the neighborhood, and sold out; and this, while also referring to town houses, is particularly true of rural habitations. Regarding the location, note whether the house stands on elevated ground at the top of a hill, exposed to wintry blasts, and to bleak and boisterous winds at all seasons of the year; or in a valley or ravine, enclosed on all sides, and with the air in a stagnant condition; or built too closely against a rather steep hillside; or, finally, on the gentle slope of a hill, with a cheerful and sunny aspect, and a pleasant prospect from the windows of the principal rooms. Always observe, or inquire into, the direction from which the prevailing winds blow. Carefully look into the surroundings of the house. The neighborhood of swamps, marshes, sluggish water-courses, stagnant ponds, or ponds in which the water-level is liable to frequent fluctuations, must be avoided; for these are the localities where malarial diseases,

fever, and ague are apt to be most frequent. Sewage farms and cemeteries, rendering establishments and soap-works, bone factories and oil distilleries, etc., are all unpleasant neighbors, and to be equally shunned. An important advantage over city houses, common to nearly all country houses, is that they are standing isolated, and surrounded with plenty of free space on all sides; for detached and even semi-detached houses are always preferable, from a health point of view, to dull, tiresome, and monotonous rows of brick or brownstone-front city houses.

Abundance of shade-trees about a country residence is much to be desired; but they should not surround a house too closely, robbing it of sunlight and a proper circulation of air. The character of the site exerts a great influence upon the healthfulness of a country house; and preference should always be given to houses on dry, sandy, or gravelly soils. Alluvial and clay soils ought to be avoided, as tending to be damp and chilly. The worst possible building-site, in suburban districts, is a low spot, recently filled with house garbage

and street rubbish. In this matter of choice of location, it must constantly be borne in mind, that, while defective construction may generally be remedied, unhealthy surroundings, an undesirable aspect, or insalubrious building-site cannot be changed. Careful search should also be made for abandoned cesspools, or overflows from cesspools into open ditches or ponds, constituting in many cases a serious nuisance. As regards the external sewerage, the drain-pipe and sewage disposal, one may safely assume, that, unless it was recently remodelled, it is not as it ought to be to prevent the contamination of the sub-soil, and the accumulation of putrefying organic matter in the pipes.

#### INSPECTION OF THE HOUSE FOUNDATIONS AND CELLAR.

Having thus ascertained whether the surroundings are free from objection, the next step should be the examination of the dwelling. Note its general construction and material, and the distance of the house from the street. It is well to com-

mence the house-inspection in the cellar, or, if there is no cellar, to make sure that the house is well raised, at least two feet, above the surface-level on brick piers; that there is abundant air-space between the ground and the building (otherwise, ground-air is liable to rise into the living and sleeping rooms, and, besides this, floor-joists and floor-boards will rot soon); and that there is no rank or decaying vegetation underneath the house. Spaces under piazzas are very apt to accumulate rotten leaves, dust, or rubbish, and should therefore be made accessible, and frequently inspected and cleaned. The cold-air box of the furnace or steam-heating apparatus should not be made to open under a piazza, for here the air stagnates, and is easily rendered foul. Light and air should be freely admitted into a cellar, and nothing kept or stored in it that might taint its atmosphere, such as rotten vegetables, swill, etc.; for any impure air in the cellar is sure to rise, and to pervade the whole house. See if the cellar-floor is of earth, concrete, or bricks, and if the cellar-walls and the floor are dry, and

free from rat-runs; look also if provision is made, by a special vent-flue carried down to the cellar, and running along some heated smoke-flue, for change of air. A healthy cellar must always be free from damp, and should be light, sunny, and airy. It should never be made the storage-place of large quantities of vegetables, causing unhealthy exhalations. A perfectly built house should be completely separated from the surrounding soil by a water and air tight cellar-floor, and by damp-proof foundation-walls, to prevent ground-air and soil-moisture from rising. If the house is separated from the ground surrounding it by areas, see if they are dry and ventilated, and have proper outlets for the removal of storm-water. The whole site of the dwelling should be dry, and, if necessary, it ought to be well underdrained; and all sub-soil water, especially where a hillside is sloping toward the house, should be cut off, and removed by special drain-trenches or tile pipes, which latter should always be kept separate or disconnected from any foul drain or cesspool.



## INSPECTION OF WALLS, ROOFS, AND ROOMS.

The first and foremost purpose of a habitation being to afford shelter against the elements, all the exposed walls of the house should be impervious to moisture ; and special pains are sometimes required in regard to this matter, in the case of frame cottages, to prevent soakage of the walls, and wetting of the wall-paper, during driving rain-storms. The outer walls of an isolated house should also be constructed so as to keep out the cold in winter, and the heat in summer. Roofs should be kept thoroughly tight, so as to be water-proof, and to prevent moisture from descending in the walls. Dripping roofs, without gutters or eaves, are a frequent cause of dampness of the soil near dwellings, and hence of damp and unhealthy foundations. Damp houses are insalubrious : the body of persons living in them is easily chilled, and people often experience draughts or a general feeling of discomfort. Indeed, many a fatal cold was contracted owing to a damp and chilly atmosphere in a country house.

All rooms should be large, comfortable, and light, with windows of ample dimensions to let in plenty of sunlight; and each window should, preferably, admit the invigorating glow of the sun during at least a portion of the day. People generally do not appreciate the beneficial effects of sunshine until compelled once to live in a cold and cheerless room, where the sun never gains entrance. Neither plants nor human beings can do without it: both grow feeble, pale, and weak. Sunlight is, in many respects, a most valuable aid to cleanliness, and at all times a good purifier. Therefore, do not shut it out. Admit to all living and bed rooms not only the pure air of heaven, but also the warm and pleasant glow of the sunlight. And if, owing to the wrong aspect of a house already built, you find that it does not enter into some of its rooms, do not choose these for the nursery, nor the principal living or bed rooms. At all events, in inspecting a house, do not forget to refer to the points of the compass to note if the house lacks sunshine,—one of the most vital factors in domestic sanitation.

Indeed, sunshine is such a precious gift that it would appear wrong and sinful to exclude it from any room of the house by any permanent arrangements, such as too broad piazza-roofs, trees placed too near a house, or heavy, dark, inside curtains. Movable blinds or shutters are better in this respect, but even they should not be kept closed too long. Says Col. Waring: "Let the sun have free access to the outside of the whole house at some time during the day, and keep shutters and blinds and windows open except when it is necessary to exclude it. Never mind faded carpets: they are not so bad as faded cheeks; and these cannot be avoided except by fresh air and ample daylight."

In bedrooms insanitary conditions ought to be most studiously avoided. They and the nurseries are the most important rooms of any house: they should be located on the sunny side of the house, and be large, airy, well-lighted, and amply ventilated, furnished cheerfully, but so as to be as much as possible free from "dust-catching and dust-yielding" materials. The furniture should

be light; and curtains, *portières*, hangings, carpets, rugs, upholstery, should be sparingly used, and the dust from them frequently removed. Window-curtains too often shut out those best of all disinfectants, sunshine and pure air. All bedding should receive a daily airing. Carpets should be avoided. It is better not to paper the walls of bedrooms; but, if they are thus finished, avoid both the dust-retaining flock-papers and poisonous arsenical papers. Bedrooms should have, if possible, an open fire-place to remove air rendered impure from breathing, or from burning lights. Slop-jars and chambers in bedrooms are often the cause of the defilement of the air, unless thoroughly cleaned by a daily application of soap and hot water. Soiled clothing should never be allowed to accumulate for any length of time in unventilated closets of bedrooms.

The servants' chambers should be as cheerful and light as the circumstances will permit: but unplastered garret rooms ought never to be used as servants' quarters; for in winter they are too cold, in summer too hot, and at all times detrimental

to health. Look carefully into the condition of walls, floors, and ceilings of all rooms; see especially that the ceilings are whitewashed, and the floors free from cracks and crevices. Examine carefully into the condition of pantries, closets, and storerooms: they should be well-lighted and well-aired to keep the food free from the least suspicion of contamination. Special cleanliness should exist wherever milk is stored; for it is well known that this very readily absorbs any impurities from the surrounding air, and becomes unfit for use. Small refrigerators for storing articles of food should never be connected directly with any pipe carrying foul sewage.

#### INSPECTION OF THE HEATING-APPARATUS.

In inspecting suburban residences occupied during all seasons of the year, the heating-arrangements must not be forgotten. Warm-air furnaces form the apparatus principally used in the better class of houses; and the most important point touching them is, that they should not take the air from the cellar. They should have

large, well-constructed cold-air boxes, taking a supply of pure air from outdoors. The inlet should not be located too near the surface of the ground, nor open near manure-heaps, privies, vaults, swill-barrels, openings into sewers, or near cesspools, and must be well protected against the entrance of dirt or dust. In much-exposed country houses, it is advisable to arrange air-inlets on opposite sides of the house, to avoid the annoyances arising from wind-pressure. As a rule, it is preferable for larger and much-exposed country houses to have two furnaces, in order not to be compelled to keep up in very cold weather a fire which would heat the furnace to red heat. The remarks made as to the best arrangement and management of the heating-apparatus of city houses may, with advantage, be here repeated. See if due provision is made for heating the halls; for this will insure a uniformity of warmth all over the house, and will help much to prevent annoying draughts.

Again, all that has been said concerning the precautions against fire applies with equal force

to country houses. It is even of greater importance, in the case of these, to guard against the dangers from fire; since the majority of such buildings are constructed entirely of wood, — hence are very inflammable, — besides being usually out of reach of fire-engines.

#### INSPECTION OF THE PLUMBING-WORK.

In these days of greater luxury and refinement, even country houses are no longer built without so-called “modern conveniences;” and it will be wise not to overlook, in our examination of the dwelling, the arrangement of these labor-saving and comfort-promoting appliances. It will suffice, however, to indicate merely the principal points of such an inquiry, as much of what has been said of the plumbing of city houses refers equally to that of houses in the country. Ascertain first if the drain outside of the house is properly laid, with pipes of small size, with sufficient grade, tight joints, and true alignment. Make sure, next, that the house-pipes are completely cut off from the outside drains and cess-

pools ; that all pipes are of a sound material, and substantially put together with air and water tight joints ; that the main drain in the house is restricted in size, run with proper and sufficient fall, or, if this cannot be had, that some flushing arrangement is provided ; that the soil-pipe is not larger than four inches in diameter, and fully ventilated, and carried well above the roof, in a perfectly straight line if possible, without any bends or offsets, an inlet being provided at the foot of the drain to establish a constant circulation of air through every foot of drain and soil pipe in the house, but not located too near a window, or near the cold-air inlet of the heating-apparatus ; that each fixture has a separate and efficient trap or barrier against entrance of foul gases ; that there is a proper supply of water to each fixture and trap ; that all plumbing-appliances are of good, smooth, and non-absorbent material, and are arranged as simple as possible, without any concealed overflow-pipes or hidden channels, but with every thing in plain sight, and their construction such that each fixture acts,



when emptied or discharged, as a flush-tank, completely scouring the traps and branch waste-pipes, which latter should form a connecting link with the main soil-pipe as direct and short as possible. Never allow any wash-basin or other plumbing-fixture to remain in a bedroom or unventilated closet adjoining it; and rather than have in any part of the house a fixture which is not used, and hence, by evaporation of the water in the trap, quickly opens a road to sewer-air, disconnect it, and close the waste-pipe carefully. People often say, when an inspection of the premises is made, "Oh, this fixture cannot be the cause of danger, or even annoying odors, for it is hardly ever used!" Popular notion seldom committed a more serious error, for with plumbing-fixtures it is dis-use which means danger. The more frequently, on the contrary, a fixture is used, *cæteris paribus*, the better will its pipe and trap be flushed.

See that the fullest light and thorough ventilation prevail in the bathroom, and closet for the house-maid's slop-sink; and make it a rule to have all plumbing exposed to view and accessible,

doing away as much as possible with the usually ill-smelling woodwork incasing such places, particularly about the kitchen-sink and the water-closet.

#### INSPECTION OF THE WATER-SUPPLY.

Two subjects of the greatest importance for all country homes, and intimately connected with each other, require particular consideration,—the water-supply, and the disposal of the household wastes. A public supply, delivering the water to all habitations in pressure-conduits or street-mains, is seldom available; and drinking-water must usually be drawn by buckets or pumps from a well on the premises, sunk to only a shallow depth, and often liable to be contaminated from surface-washings, or by careless dipping into it of unclean vessels. Driven wells are not so liable to surface contamination; yet even they may be poisoned by leakage of sewage, unless sunk to a very great depth, and penetrating below some impervious stratum. It sounds like a truism to say that wells supplying drinking-water

must be most scrupulously watched, and kept free from contamination; yet how seldom is proper care bestowed upon this matter! The drain which carries the liquid wastes from the house to a cesspool often passes near the well; and unless the pipes are laid with unusual care and forethought, by experienced workmen, the imperfect and often uncemented joints and broken pipes allow the slop-water to leak into the soil, from which it passes by filtration into the well.

But the most frequent and most dangerous causes of contamination of wells are the leaching cesspool (that vast receptacle of decomposing organic matter from the household) and the privy, both generally located, on account of convenience and economy, very near to the house. The well from which the household draws its supply of drinking-water is thoughtlessly located, more often than not, in close proximity to either of them. It is difficult to state the least distance that ought to exist between a well and a privy or a leaching cesspool, if the latter is at all to be tolerated. While some put it at from one to two hundred feet, the

safer rule would be always to put the cesspool in the farthest available corner of the lot. Even if such a location is feasible, it must not be forgotten that a leaching cesspool is at best a makeshift and an unsanitary device; and that, when placed far away from your own dwelling to insure safety, it may contaminate a spring or a water-course from which your neighbor down the hill draws his supply of potable water. It is much safer to establish a rigid rule, that, wherever your house and the neighborhood must depend on wells or springs for water-supply, *leaching cesspools must not be tolerated at all*; and, *vice versa*, wherever leaching cesspools exist, do not use water from any pump, draw, or driven well.

It is quite easy to ascertain if any hidden connection exists between a leaching cesspool, house-sewer, or privy-vault and a well or cistern. Add to the contents of the cesspool or privy-vault a large quantity of salt, or introduce a strong salt solution into the house-drain. Make a chemical test of the well or cistern water for chlorine, before and after pouring the salt solution; and if, in the

latter instance, the analysis reveals a largely increased amount, it is a sure sign of a leakage existing. To test for chlorine, fill a glass test-tube about half full with water, and add to it a few drops of a nitrate of silver solution. The presence of chlorine is indicated by a white precipitate, consisting of chloride of silver.

Another, although more expensive and not readily available method, is to apply the "lithia" test, by throwing into the cesspool, privy-vault, or sewer some lithium salts, and testing the well-water afterwards for the lithium, by means of the spectroscope, which clearly indicates by the peculiar red lithium line even minute amounts of this element in the water.

It is far less objectionable to make use of a tight cesspool. Examine it carefully as to dimensions and material. Measure its distance from the house; see if it is built water-tight, well covered, and how ventilated. Let it be small in size, and frequently emptied and cleaned, and occasionally disinfected. If there are any privies, note their location and distance from the house, the

well, and the cistern. Note if they are offensive or inodorous, and well ventilated, and constructed in such a manner as to be readily emptied and cleaned, and fully protected against entrance of rain or moisture.

Before permitting the water from a well to be used in your household, make a thorough inspection of the well; note if it is a dug or driven well, a shallow or deep well; measure its depth and the depth of the average water-level below the surface; examine the inside lining of the well as to imperviousness; see how the well is covered, and how protected against the entrance of surface-washings or vermin.

Next have a sanitary examination of the water made by some competent chemist. Good water ought to be agreeable to the palate, cool, yet not too cold; it should be colorless, clear, and bright, free from odor, without sediment or suspended matter, and not too hard. A water-analysis should cover at least the following points: First, observe the color of the water, which is readily done by filling a tall glass vessel, and look-

ing down upon the water. A decided greenish, yellow, or brown tint indicates animal or vegetable contamination. The sense of smell may be of some value in judging the quality of a certain water by filling a bottle partly, and closing it with a glass stopper, next agitating it violently, and then smelling at the mouth of the bottle. A slight warming of the bottle may aid in disclosing impurities. Next note the taste of the water; but, in doing so, it should be remembered that waters which do not taste offensively may yet be badly polluted with sewage. It is a well-known fact, that some of the most sparkling and pleasant well-waters revealed, upon examination, a very bad pollution. After noting the principal physical qualities, a chemical analysis should be made, covering the following points: the amount of total solids; the hardness of the water, especially its permanent hardness; the amount of chlorine, of free ammonia, of nitrates, and of the organic matter contained in the water. As a rule, a qualitative analysis is sufficient to throw light upon the unwholesomeness of a suspicious water; in more

important cases, however, a quantitative analysis should also be performed. Occasionally it becomes necessary to test a water for poisonous metals, such as zinc, lead, or copper. A microscopical examination often adds considerable information upon the quality of a certain water.

The chemical analysis is of equal importance in the case of deep and shallow or surface wells, as in the case of cistern-water, or lake or brook water. If the examination of well-water reveals any pollution by sewage, it is advisable to use only boiled and filtered rain-water for cooking and drinking purposes. If drinking-water is derived from a running stream or brook, carefully inspect the banks to a long distance above the point where the water is taken, to make sure that no sewage-slops, manufacturing wastes, or surface-washings from manured fields forming a part of the gathering grounds, run into the stream.

With the exception of, perhaps, the smallest cottage buildings, the rain falling upon roofs commonly yields water sufficient in quantity for all ordinary household purposes; and, if the most ordinary



precautions only be observed in collecting and storing it, rain-water constitutes a desirable and healthful beverage. It is not advisable to collect rain from zinc roofs, or roofs that are painted. The best roofing material is slate or else tiles ; but shingle roofs will answer, except that the water from them acquires at times a taste from decaying wood-splinters washed into the cistern. Care should be taken to have the roofs and gutters clean ; and the first washings, containing mineral dust, soot, spores of plants, or other organic matter, ought always to be allowed to run off on the surface by a cut-off or separator, worked by hand, or else arranged to act automatically. It is also very necessary to see if any slop-water can find its way, directly or indirectly, into the cistern. The cistern for storing rain-water should be built thoroughly water-tight, and be protected against any possible pollution, especially against entrance of surface-washings, or leaves of trees, insects, small animals, and all kinds of animal and vegetable impurities. It should be ventilated, and thoroughly cleaned every summer. The overflow-pipe

from a cistern must never discharge into any foul drain-pipe or cesspool. It is a good plan, which adds only a trifle to the cost, to build a partition of bricks laid with loose joints, dividing the cistern into a large and a small compartment, which dividing wall acts as a filter. In summer it is a good precaution to boil the water first, next to cool it with ice, and to aërate it before drinking; but such ice, frequently impure, must not be placed in the water. The proper way is to have water-coolers with outer and inner chambers, — the outer for the melting ice, the inner one for the pure water. Drinking-water may be purified by means of domestic filters: but, if these are used, they must not be left in charge of thoughtless servants, since they require to be frequently cleaned; otherwise, their purifying action ceases, and the filtered water soon acquires a bad taste, due to the organic impurities retained in the filtering material. It is desirable to have filters constructed in such a manner as to allow of easy cleaning and aëration. If a tank is arranged to supply plumbing-fixtures, it should be placed in the attic in

some accessible place, protected against entrance of dust or vermin, and ventilated by a suitable opening into the outer air. The best material for such tanks is slate, with properly made cement joints, or else well-painted wrought-iron, or finally tinned copper lining. Lead linings are not safe; as they are, in some cases, attacked by water, especially by soft water. It is better not to draw any water for drinking or culinary purposes from such a tank; for, no matter how pure the water may be when conveyed into a dwelling, it may, by storage, be rendered contaminated and unfit for use, owing to vapors, gases, dust, smoke, or floating organic impurities present about water-tanks. The tank should, under no circumstances, be used to supply directly the valve attached to water-closet bowls; for it is necessary that each water-closet be flushed separately from its own flushing cistern.

#### INSPECTION OF THE METHOD OF DISPOSAL OF HOUSEHOLD WASTES.

Concerning the best way of disposing of household wastes, and of avoiding the cesspool nuisance,

the aim should be, first, to remove all fouled water from the house, and its immediate vicinity, as fast as generated; and, next, to utilize the slops, as much as possible, for agricultural purposes, to enrich the soil, and thus to give nourishment to plants and shrubbery in the garden. The upper layers of the earth possess the power of destroying within a short time all buried organic matter, because the oxygen of the atmosphere has free access to the pores of the soil near the surface of the ground. A good substitute for the leaching cesspool, in the case of smaller country houses, is a tight sewage tank, located far away from, and on a lower level than, the well, built of brick, laid in hydraulic cement, to which the liquid house-wastes are delivered, and from which they may be pumped by means of an ordinary garden pump with hose attached, and distributed in the vegetable garden. If the house is provided with water-closets, it is necessary to build an intercepting chamber, or catch-basin, to separate the solids from the liquid sewage. It is of no advantage whatever to separate the kitchen slops from the water-closet wastes

by using two cesspools. Stagnant kitchen slops decompose as rapidly, and give off as bad gases, as putrefying human excreta. Surface irrigation may sometimes be objectionable where the garden is too near the house. The trouble of pumping out a tight cesspool increases wherever the water-supply is ample, and where a larger number of plumbing-fixtures is constantly used. If the dimensions of the cesspool are enlarged, so as to avoid too frequent pumping out, the consequence is that the sewage is stored for a considerable space of time, and that decomposition sets in, which makes its proper and innocuous disposal a matter of more difficulty, and, in fact, may cause frequent complaints of offensiveness.

In such cases, a better system, and one capable of wide adaptability, is the *sub-surface irrigation system*, in which the liquid is distributed by gravity, at a depth of about ten inches below the surface, by means of small porous tile drains, laid in parallel lines under a lawn, grass-land, or in the garden. The sewage should be discharged into the distributing pipes in a large volume, and at

intervals only, by manual labor, or, preferably, automatically by means of a self-acting flush-tank. Special care is necessary wherever to the slop-water is added the discharge from water-closets in the house. An intermittent discharge is very desirable to allow the filtered liquid to soak away in the ground, while the organic impurities attaching to the earth are rapidly oxidized, and assimilated by vegetation. In a properly arranged system, the irrigation field will be entirely free from noisome odors, and the purification process will continue even in severely cold weather. The sub-surface irrigation field should be entirely free from trees, as the roots of these would soon grow into the tiles, and obstruct them.

#### INSPECTION OF THE HOUSE SURROUNDINGS.

Having taken steps to secure a properly arranged system of disposal of the house-sewage, and a water-supply ample in quantity, of perfect purity, and well guarded against contamination, it remains to remove any causes tending to a possible pollution of the atmosphere around a country

house. Observe if the lawns and walks, the yard and the garden, are kept in a neat and inoffensive condition. Let every possible precaution be taken to prevent any accumulation of rotten vegetable matters or kitchen offal of any kind. All animal and vegetable refuse from the kitchen — such as cabbage-leaves, meat-offal, fish-bones, potato-parings, etc. — should be dried and burnt up in the kitchen range or in a small domestic garbage-cremator. If a dust-bin is required, let it be a small, portable one, circular in section, made of strong iron protected against rust, and with a well-fitting metal cover. Wooden dust-barrels are utterly unsuitable. In all cases, dust-bins or garbage-pails should be protected against rain or dampness. Remove manure-heaps or accumulations of rotten vegetation or animal matters. The exposure of these to the scorching heat of a midsummer sun accelerates putrefaction, and is often the cause of illness, due to breathing such impure air. See to it that all ventilation-pipes for drains or the sewage-tank are carried to a safe height above ground. Abolish any privy for servants or farmhands, and

substitute for it a properly constructed, well-ventilated, and well-managed earth-closet. Never tolerate the throwing out of any slops from the kitchen window. If the servant-girl would pour the slops on to a different spot at each time, so as to avoid a saturation and fouling of the soil, the practice might not call for severe condemnation. But this will rarely be the case ; and nothing could be more disgusting than a large, offensive pool of stagnant, foul water, exposed to the scorching rays of the sun.

Barns, stables, cattle-yards, pigsties, hen-coops and other fowl-houses, dog-kennels, and their immediate surroundings, should all be kept scrupulously clean and inoffensive ; and their floors ought always to be dry, and free from moisture. See that they are not too near the dwelling, and have them looked after from time to time, especially if located close to the habitation, and in a direction from which the prevailing winds blow.



INSPECTION OF THE PROPER REMOVAL OF  
STORM-WATER.

Even pure surface-water from rain-storms or snow-falls should be carefully removed to prevent undue dampness or rising moisture. Where rain-leaders do not deliver into a storage cistern, they ought to discharge into earthen pipes, laid with great care and with a true grade on a firm foundation, delivering the water into some convenient ditch, open water-course, or road-gutter. Rain-water should be removed to at least such a distance from the habitation that soakage into the sub-soil will not cause dampness of the cellar-walls. It is inadmissible to connect the rain-leaders to the house-drain if the latter discharges into a cess-pool; and it is quite important to ascertain that no rain-water pipe, terminating perhaps near upper bedroom windows, acts as a ventilator to any foul drain. In all country houses not discharging the sewage into a system of sewers or a large river, or into the sea, the rainfall must be kept entirely separate from the sewage. That portion of the rain fall-

ing directly on the ground surrounding the house should be diverted, by proper grading, so as to protect the foundation-walls. Surface grading is especially required wherever roofs are left without gutters. Rain-water and melted snow from paved yards and areas should likewise be removed by surface or underground channels discharging at a distance from the dwelling, where water may safely be absorbed by vegetation, or soak away into the soil. Unpaved yards and walks absorb water where the soil is loose and porous; but, in the case of impervious clay soils, properly graded gutters should be constructed to keep the walks dry and in a good condition.

#### SUMMER BOARDING-HOUSES AND SUMMER-RESORTS.

While the foregoing remarks, incomplete as they no doubt are in some respects, refer particularly to houses already built, for sale or to rent, for permanent or transient occupancy, it is hardly necessary to state that the same rules ought to be followed in the case of dwellings which it is proposed to erect. Much of what has been said

applies likewise to boarding-houses and summer hotels at the seaside or on the mountains; but in these the danger of infection from unsanitary conditions of drainage and water-supply is multiplied, owing to the large number of people seeking pleasure or rest, and crowded together in a small space, and also because such hotels are fitted up more liberally with what are called "modern conveniences." It is true that at the summer resorts the evil influences of a polluted water-supply or contaminated air are largely counteracted by the outdoor exercise; by the greater number of hours spent in the fresh air, at the beach, on the water, or in the woods; and by the temporary abandonment of business thoughts. Yet this ought not to be a valid reason for relaxing the watchfulness against unhealthful influences; for neither sea-air nor exhilarating mountain breezes possess the power to counteract completely the injurious effects of drain or cesspool air, breathed in the shut-up rooms at night. One frequently encounters instances where some illness, contracted at such places, breaks out only after the return to the

city house and to business. All large hotels and boarding-houses should be annually re-inspected, and all their drainage and water-supply appliances put in a proper condition. The purity of the sources of drinking-water, in particular, should be guarded with the greatest care, and the arrangements for the disposal of the sewage be made as perfect as is attainable. Then, and only then, will the healthful and invigorating influences of summer days spent in the country be of lasting benefit to those who leave their comfortable city homes in order to improve their health.

#### NECESSITY OF PERIODICAL INSPECTION.

In conclusion, I desire to emphasize the necessity of a *periodical* inspection of the sanitary condition of all kinds of buildings. It is not sufficient to spend once a large amount of money to put the sanitary arrangements in a good condition. Constant supervision and thought are required to keep every thing in good order. Professor Fleming Jenkin of Edinburgh, who gave the first impetus towards the establishment of sanitary associations,

thus forcibly explains the necessity of periodic inspection : —

“ It is not enough to call in the engineer, and have all put in the best order once in a way. This is, indeed, very necessary in most cases, — how necessary, few know ; but when it has been done, the inspection must be maintained. The case is quite analogous to that of a steam-boiler. We must, in the first instance, provide ourselves with a good article, designed by competent engineers, and experimentally tested ; but we must also pay competent men to come year after year, and examine whether any deterioration has occurred.”

It is, however, by no means always required that an expert should be called in at each time, to make the inspection ; for if a householder or the mistress of a house would take pains to keep themselves well informed about sanitary matters, and to understand the chief points to be inquired into, they would be able to perform the inspection themselves, after a house has been once properly arranged and built : and it might even be advantageous to combine such an inspection with the

annually re-occurring house-cleaning, and not to wait until some noxious smells indicate that the plumbing has become defective, or that other serious defects exist. As Col. Waring has truly said, —

“It is not unusual for a householder, unless his house fairly stinks, to consider it as ‘sweet as a rose,’ and to rest happy in the conviction that it is perfectly healthy. The truth is, that a foul odor is not in itself poisonous. When it exists in a house, it indicates a source of foulness which may also be a source of disease. But, unfortunately, the source of disease may, and often does, exist without obvious bad smells. The fainter odors which more often accompany dangerous emanations are not perceptible to those who live constantly subject to them. To one fresh from the country, they are almost always obvious in an average city house.”

Most people are only too apt to postpone the inspection until much too late, when a severe case of illness in the family, or a death from one of the preventable diseases, opens their eyes to

the dangers by which they are surrounded. To send for an expert after a fatal case of illness, might well be compared with the calling-in of an inspecting engineer after a steam-boiler explosion has occurred. If, in making a sanitary house-inspection, it is considered impracticable to remove tight woodwork, rip up floors, cut up walls, dig holes, so as to clearly expose every fixture, trap, and every foot of waste or vent-pipe, and to gain access to the interior of drains, or to make sure that no old cesspools exist under a house, the results of the examination will enable the inspector to make a general or preliminary report only. It is, however, always better to make a thorough examination; and in that case a complete report of the sanitary inspection of a dwelling should contain: (1) a general statement describing the sanitary condition of a building at the time of the inspection; (2) a detailed statement of the sanitary defects discovered, with reasons why the arrangements are faulty; (3) a detailed recommendation of improvements to be made to put a house in a proper and healthful condition.

To sum up, no house should be purchased or leased, in the city or in the country, the sanitary condition of which has not been carefully examined into, and its fitness for occupancy certified, by some well-educated, disinterested professional man.

There is not the slightest doubt, that, if the public will thus insist upon healthful surroundings and salubrious buildings, a greater attention will soon be paid by landlords and builders to the important questions of drainage and plumbing, heating and ventilation, lighting and safety from fire, water-supply and disposal of sewage. A healthful home having been once secured, it becomes the sacred duty of the householder to inquire at frequent intervals into its continued good sanitary condition. To aid the householder in the search for such structural defects as may endanger the health of his household is, the object of this — *Guide to Sanitary House-Inspection*.



# INDEX.

|                                | PAGE    |                                      | PAGE    |
|--------------------------------|---------|--------------------------------------|---------|
| <b>A</b> DMISSION of air . . . | 75, 77  | Building-site . . . . .              | 23, 102 |
| Air-inlet for house-drains . . | 35      | Burners, Choice of . . . . .         | 73      |
| Air-test, simple method of de- |         | By-passes in vented traps . .        | 50      |
| termining amount of car-       |         | <b>C</b> ARBONIC-ACID test . . . . . | 79      |
| bonic acid . . . . .           | 79      | Carpets, objectionable as col-       |         |
| Apartment-houses . . . . .     | 90      | lecting dust, and absorbing          |         |
| Apparatus for disinfecting wa- |         | impurities . . . . .                 | 86, 110 |
| ter-closets . . . . .          | 44      | Ceiling ventilation . . . . .        | 77      |
| Area-drains . . . . .          | 36      | Cellar, Inspection of the . .        | 25, 105 |
| Arrangement of gas-piping . .  | 67      | Cement pipe for house-drain, 32, 33  |         |
| Arrangements for warming the   |         | Cesspools . . . . .                  | 27      |
| house . . . . .                | 56      | Cesspools, Leaching . . . . .        | 117     |
| Arsenic in wall-papers . . .   | 29, 110 | Cesspools, Tight . . . . .           | 119     |
| Ash-barrels . . . . .          | 56      | Cesspool trap . . . . .              | 32      |
| <b>B</b> AD odors . . . . .    | 84      | Chemical examination of wa-          |         |
| Bathroom . . . . .             | 44, 115 | ter . . . . .                        | 119     |
| Bedrooms . . . . .             | 28, 109 | Chimneys . . . . .                   | 31, 88  |
| Bell-traps . . . . .           | 43      | Choice of a site . . . . .           | 102     |
| Boiler inspector . . . . .     | 64      | Choice of gasburners . . . .         | 73      |
| Boiler, Kitchen . . . . .      | 54      | Choosing a dwelling . . . . .        | 9       |
| Boiler, Steam-heating . . . .  | 64      | Cisterns . . . . .                   | 123     |
| Brick drains under houses . .  | 32      | City houses, Inspection of . .       | 22      |
| Building-materials . . . . .   | 27      | Closets . . . . .                    | 111     |

|                                    | PAGE     |                                 | PAGE    |
|------------------------------------|----------|---------------------------------|---------|
| Cold-air box, 35, 58, 59, 89, 105, | 112      | Essentials of perfect salubrity |         |
| Cold-air ducts . . . . .           | 77       | in a house, quoted from         |         |
| Combustion of gas . . . . .        | 71       | Dr. B. W. Richardson . .        | 21      |
| Conductor-pipes . . . . .          | 36       | Evaporation of water in traps,  | 115     |
| Construction of floors . . . .     | 30       | Examination, Detailed, of a     |         |
| Contamination of the soil . . .    | 100      | system of ventilation . .       | 78      |
| Country houses, Inspection of,     | 99       | Examination of wells . . . .    | 119     |
| Cowls . . . . .                    | 38       | FERRULES, of brass, for joints  |         |
| DAMPNESS of walls . . . . 28,      | 107      | between lead and iron           |         |
| Damp-proof courses . . . . .       | 25       | pipe . . . . .                  | 42      |
| Decaying organic matters, the      |          | Filters . . . . .               | 124     |
| cause of bad smells . . . .        | 85       | Fire-escapes . . . . .          | 98      |
| Defective flues . . . . .          | 88       | Fireplace, Open . . . . .       | 57      |
| Defective water-closets . . . .    | 44       | Fireplace, Ventilating . . . .  | 57      |
| Defects in drainage and plumb-     |          | Fireplaces for ventilation . .  | 76      |
| ing . . . . .                      | 49       | Fire prevention . . . . .       | 87      |
| Defects in gas-piping . . . . .    | 68       | Fire-proof flats . . . . .      | 91      |
| Direct-indirect radiation . . .    | 63       | Fire-risks in flats . . . . .   | 91      |
| Direct radiation . . . . .         | 62       | Fixtures, Inspection of plumb-  |         |
| Disinfecting apparatus . . . .     | 44       | ing . . . . .                   | 41      |
| Disposal of household wastes,      | 125      | Floor-construction . . . . 30,  | 111     |
| Domestic filtration . . . . .      | 124      | Flues, Defective . . . . .      | 88      |
| Drainage of soil . . . . .         | 106      | Flues, Hot-air . . . . .        | 61      |
| Drainage plan . . . . .            | 55       | Flush-tank for sewage disposal, | 128     |
| Drain-pipes of iron . . . . .      | 34       | Foul air . . . . .              | 85      |
| Drinking-water, Contamina-         |          | Foundation-walls . . . . .      | 25      |
| tion of . . . . .                  | 100, 116 | French flats . . . . .          | 90      |
| Drip-pipes . . . . .               | 49, 85   | Fresh-air supply to heating-    |         |
| Driven wells . . . . .             | 116      | apparatus . . . . .             | 63, 105 |
| Dust-bin . . . . .                 | 129      | Fresh-air inlet . . . . .       | 35, 114 |
| EARTH-CLOSETS . . . . .            | 130      | Furnace, Warm-air . . . . .     | 57, 111 |
| Eassie, William, C. E., quoted,    | 13       | Furniture, Healthy arrange-     |         |
| Essentials of a healthful home,    | 19       | ments of house . . . . .        | 86, 110 |

|  | PAGE        |  | PAGE         |
|--|-------------|--|--------------|
| <b>G</b> ARBAGE disposal . . . . .                           | 55, 99, 129 | Household wastes, Methods of disposal of . . . . .     | 125          |
| Gasburners, Various kinds of, 72, 74                         |             | House-surroundings . . . . .                           | 23, 102, 128 |
| Gas-fixtures . . . . .                                       | 89          | House-ventilation . . . . .                            | 74           |
| Gas-lighting . . . . .                                       | 66          | How to prevent corrosion in steam-boilers . . . . .    | 65           |
| Gas-meter . . . . .  | 67          | How to save gas . . . . .                              | 73           |
| Gas-pipes and fixtures, How to test . . . . .                | 69          | <b>I</b> CE, for cooling cistern-water, . . . . .      | 124          |
| Gas-pipes, how put together . . . . .                        | 66          | Illuminating-gas . . . . .                             | 66           |
| Gas-piping, Defects in . . . . .                             | 68          | Inlets for warm air . . . . .                          | 61           |
| Gas, Waste of . . . . .                                      | 72          | Indirect radiation . . . . .                           | 62           |
| Germs of disease . . . . .                                   | 52          | Inspection of apartment-houses . . . . .               | 94           |
| Glass globes, Size and shape of . . . . .                    | 74          | of arrangements for warming the house . . . . .        | 56, 111      |
| Governor-burners . . . . .                                   | 74          | of arrangements insuring safety against fire . . . . . | 87           |
| Grease-trap . . . . .  | 27, 43      | of bathroom . . . . .                                  | 44, 115      |
| Gullies in cellar-floor . . . . .                            | 26          | of cellar . . . . .                                    | 25, 104      |
| <b>H</b> AMMER-TEST for steam-heating boilers . . . . .      | 64          | of city houses . . . . .                               | 22           |
| Healthful home, Essentials of a . . . . .                    | 19          | of country houses . . . . .                            | 99           |
| Healthfulness of town and country houses compared, . . . . . | 100         | of garbage disposal . . . . .                          | 55           |
| Heating-apparatus . . . . .                                  | 56, 88, 111 | of gas-lighting arrangements . . . . .                 | 66           |
| Height of apartment-houses to be limited by law . . . . .    | 92          | of gas-meter . . . . .                                 | 69           |
| Honeycombed soil-pipes . . . . .                             | 37          | of house-drains . . . . .                              | 34           |
| Hopper-closets . . . . .                                     | 42          | of house-foundations . . . . .                         | 104          |
| Hot-air flues . . . . .                                      | 61, 63, 88  | of house-ventilation . . . . .                         | 74           |
| House-drain, of brick . . . . .                              | 32          | of methods of disposal of household wastes . . . . .   | 125          |
| of cement or terra-cotta pipe . . . . .                      | 32          | of plumbing-fixtures . . . . .                         | 41, 114      |
| of iron pipe . . . . .                                       | 34          | of plumbing and sewerage . . . . .                     | 31, 113      |
| House furniture . . . . .                                    | 86          |  |              |

|                                      | PAGE         |                                       | PAGE    |
|--------------------------------------|--------------|---------------------------------------|---------|
| Inspection of radiators . . .        | 63           | Leaching cesspools . . . .            | 117     |
| of soil-pipe . . . . .               | 36           | Lead-pipe joints . . . . .            | 42      |
| of steam-heating boiler .            | 64           | Lead soil-pipes . . . . .             | 37      |
| of streets . . . . .                 | 22           | Leakages in gas-pipes and gas-        |         |
| of storm-water removal .             | 131          | fixtures . . . . .                    | 68      |
| of structural details . .            | 27           | Leaky sewer-pipes causes of           |         |
| of surroundings and of the           |              | well-water contamination,             | 117     |
| soil . . . . .                       | 23, 102, 128 | Light and air in bathrooms .          | 115     |
| of tenement-houses . . .             | 95           | Light-and-air shafts . . .            | 91, 97  |
| of traps . . . . .                   | 35           | Low-pressure steam-heating            |         |
| of walls, roofs, rooms . .           | 107          | apparatus . . . . .                   | 62      |
| of washbasins . . . . .              | 48, 115      | <b>MAIN</b> house-drain . . . . .     | 32      |
| of water-closets . . . .             | 47           | Malaria . . . . .                     | 102     |
| of water-supply . . . .              | 53, 116      | Management of heating-appa-           |         |
| of yard . . . . .                    | 26           | ratus . . . . .                       | 58, 112 |
| Iron drains . . . . .                | 34           | Mason or cesspool trap . . .          | 32      |
| Irrigation, Sub-surface . .          | 127          | Materials for building . . .          | 27      |
| <b>JENKIN</b> , Professor Fleming,   |              | Material for tank-lining . .          | 125     |
| quoted . . . . .                     | 134          | Metallic tips for gasburners .        | 74      |
| Joints, Defective, in soil-          |              | Method for determining                |         |
| pipes . . . . .                      | 37, 38       | amount of carbonic acid               |         |
| in iron pipe . . . . .               | 37, 38       | present in the air . . .              | 79      |
| in lead pipe . . . . .               | 42           | Methods of disposal of house-         |         |
| Leaky, in house-drains,              | 32, 34       | hold wastes . . . . .                 | 125     |
| Junction between soil-pipe and       |              | Moisture in air . . . . .             | 77      |
| house-drain . . . . .                | 33           | Movement of air-currents . .          | 77      |
| <b>KINGSLEY</b> , Charles, quoted on |              | <b>NECESSITY</b> of periodical house- |         |
| ventilation . . . . .                | 75, 81       | inspection . . . . .                  | 134     |
| Kitchen boiler . . . . .             | 54           | Non-conducting covering for           |         |
| Kitchen offal . . . . .              | 55           | steam-pipes . . . . .                 | 63      |
| Kitchen sink . . . . .               | 43           | Nurseries . . . . .                   | 109     |
| Kitchen ventilation . . . .          | 78           | <b>ODORS</b> , Bad, in a house . .    | 84      |
| <b>LAUNDRY</b> tubs . . . . .        | 43           | Open fireplace . . . . .              | 57      |

|                                     | PAGE         |                                 | PAGE        |
|-------------------------------------|--------------|---------------------------------|-------------|
| Openings of fresh-air inlets        |              | Refrigerators . . . . .         | 111         |
| obstructed . . . . .                | 38           | Registers . . . . .             | 61          |
| Outlets for impure air . . .        | 62           | Regulators of gas-pressure .    | 73          |
| Overflow channels, hidden, 44,      | 114          | Removal of storm-water . .      | 131         |
| Overflow pipes for cisterns .       | 124          | Return-bends objectionable .    | 38          |
| <b>PAN-CLOSET</b> . . . . .         | 42, 46       | Richardson, Dr. B. W., quoted,  | 21          |
| Pantries . . . . .                  | 111          | Roof, Tightness of . . . . .    | 31, 97, 107 |
| Pantry-sink . . . . .               | 43           | Roof, Material for . . . . .    | 123         |
| Patent disinfecting apparatus .     | 44           | Rooms . . . . .                 | 28, 108     |
| Peppermint test described . .       | 39           | Running-traps . . . . .         | 33          |
| Periodical house-inspection .       | 134          | <b>SAFE</b> pipes . . . . .     | 47          |
| Plan of house, showing water-       |              | Sanitary certificate . . . .    | 11, 13      |
| pipes, drains, etc. . . . .         | 55           | Sanitary house-inspection, Ne-  |             |
| Plug and chain arrangement .        | 44           | cessity of . . . . .            | 8           |
| Plumbing defects . . . . .          | 49           | Servants' rooms . . . . .       | 31, 110     |
| Plumbing-fixtures . . . . .         | 41, 98, 114  | Servants' water-closet . . . .  | 42          |
| Plumbing-work to be kept ex-        |              | Sewage-tanks . . . . .          | 126         |
| posed to view . . . . .             | 115          | Sewerage and sewage disposal    |             |
| Plumbing, Inspection of . . .       | 31, 113      | of country houses . . . .       | 104         |
| Pressure governors . . . . .        | 73           | Sewerage, Inspection of . . .   | 31          |
| Pressure of gas, Excessive . .      | 72           | Sewer-gas . . . . .             | 51          |
| Pressure-test . . . . .             | 38           | Siphonage of traps . . . . .    | 36, 38      |
| Prevention of corrosion in          |              | Sizes of waste pipes and traps, | 42          |
| steam-heating boilers . . .         | 65           | "Skin" buildings . . . . .      | 14          |
| Prevention of dust . . . . .        | 84, 86       | Slop-sink . . . . .             | 47          |
| Prevention of fire . . . . .        | 87           | Smoke-flue . . . . .            | 88          |
| Privies . . . . .                   | 27, 117, 129 | Smoke-test, for soil-pipes .    | 38, 40      |
| <b>RADIATION</b> , Direct and indi- |              | Soil-pipes . . . . .            | 36, 114     |
| rect . . . . .                      | 62           | Soil-pipes, Upper terminus of,  | 38          |
| Radiators . . . . .                 | 63           | Speaking-tubes as channels of   |             |
| Rain-leaders . . . . .              | 36, 131      | foul air . . . . .              | 85          |
| Rain-water . . . . .                | 123, 131     | Speculative builder, Houses of  |             |
| Removal of . . . . .                | 36, 131      | the . . . . .                   | 15          |

|                                     | PAGE        |  | PAGE         |
|-------------------------------------|-------------|--|--------------|
| Staircase . . . . .                 | 30, 91, 98  | Test of pipe-system by smoke, 38, 40     |              |
| Steam-coils . . . . .               | 62          | of pipe-system by water-                 |              |
| Steam-heating apparatus . . . . .   | 62          | pressure . . . . .                       | 39           |
| Steam-heating boiler . . . . .      | 64          | Trap, Cesspool or mason's . . . . .      | 33           |
| Stovepipes . . . . .                | 89          | on main drain . . . . .                  | 35, 113      |
| Stoves, Heating by . . . . .        | 56          | Trapping of fixtures . . . . .           | 114          |
| Storerooms . . . . .                | 111         | of leaders . . . . .                     | 36           |
| Storm-water removal . . . . .       | 131         | of yard and area drains . . . . .        | 36           |
| Street, Inspection of the . . . . . | 22          | Traps, running . . . . .                 | 33           |
| Structural details, Inspection      |             | forced by back pressure . . . . .        | 38           |
| of . . . . .                        | 27          | <b>U</b> RINALS . . . . .                | 46           |
| Sub-surface irrigation . . . . .    | 127         | <b>V</b> ENTILATING fireplace . . . . .  | 57           |
| Suburban and summer resi-           |             | caps . . . . .                           | 38           |
| dences . . . . .                    | 99          | Ventilation of bathroom . . . . .        | 115          |
| Summer boarding-houses and          |             | of cellar . . . . .                      | 106          |
| summer resorts . . . . .            | 132         | of house . . . . .                       | 74           |
| Sunlight . . . . .                  | 108         | of kitchen . . . . .                     | 78           |
| Surroundings and soil, 23, 102, 128 |             | of soil-pipe . . . . .                   | 36           |
| <b>T</b> ANK, Water . . . . .       | 54, 98, 125 | of water-closet apartment, 78            |              |
| T-branches objectionable . . . . .  | 35          | <b>W</b> ALL-PAPERS, Arsenical . 29, 110 |              |
| Tenement-houses . . . . .           | 95          | Walls, Inside finish of . . . . .        | 28           |
| Test for connection between         |             | Inspection of . . . . .                  | 107          |
| well and cesspool . . . . .         | 117         | Wardrobes . . . . .                      | 86           |
| Test for gas-pipes . . . . .        | 69, 70      | Waring, Col. George E., jun.,            |              |
| Test for sewer-gas . . . . .        | 52          | quoted . . . . .                         | 11, 109, 136 |
| Test for steam-boiler . . . . .     | 64          | Warm-air furnace . . . . .               | 57, 111      |
| Testing water . . . . .             | 119         | Warming the house . . . . .              | 56, 111      |
| Test of pipe-system by acetate      |             | Washbasin . . . . .                      | 43, 47       |
| of lithium and the spec-            |             | Washbasins in sleeping-rooms             |              |
| troscope . . . . .                  | 41          | objectionable . . . . .                  | 47, 115      |
| Test of pipe-system by musk,        | 41          | Waste of gas . . . . .                   | 72           |
| of pipe-system by pepper-           |             | Waste-pipes . . . . .                    | 38           |
| mint . . . . .                      | 39          | Water analysis . . . . .                 | 119          |

|                                       | PAGE    |  | PAGE         |
|---------------------------------------|---------|--|--------------|
| Water-closet for servants . . . . .   | 42      | Wells . . . . .                        | 27, 116, 119 |
| ventilation . . . . .                 | 78      | Windows . . . . .                      | 28, 108      |
| Water-courses, old . . . . .          | 24      | Wiped joints . . . . .                 | 42           |
| Water-pipes, arrangement of . . . . . | 53      | Wire lathing . . . . .                 | 89           |
| Water-pressure test . . . . .         | 39      | Wolpert's test-apparatus for . . . . . |              |
| Water-supply of city houses . . . . . | 53      | carbonic acid in air . . . . .         | 79           |
| of country houses . . . . .           | 116     | YARD, Inspection of the . . . . .      | 26, 129      |
| to plumbing-fixtures . . . . .        | 98, 114 | drains . . . . .                       | 36, 132      |
| Water-tank . . . . .                  | 54, 125 |  |              |





# SHORT-TITLE CATALOGUE

OF THE  
PUBLICATIONS  
OF

JOHN WILEY & SONS,

NEW YORK.

LONDON: CHAPMAN & HALL, LIMITED.

ARRANGED UNDER SUBJECTS.

Descriptive circulars sent on application. Books marked with an asterisk are sold at *net* prices only, a double asterisk (\*\*) books sold under the rules of the American Publishers' Association at *net* prices subject to an extra charge for postage. All books are bound in cloth unless otherwise stated.

## AGRICULTURE.

|  |              |
|--|--------------|
| Armsby's Manual of Cattle-feeding.....                           | 12mo, \$1 75 |
| Principles of Animal Nutrition.....                              | 8vo, 4 00    |
| Budd and Hansen's American Horticultural Manual:                 |              |
| Part I.—Propagation, Culture, and Improvement.....               | 12mo, 1 50   |
| Part II.—Systematic Pomology.....                                | 12mo, 1 50   |
| Downing's Fruits and Fruit-trees of America.....                 | 8vo, 5 00    |
| Elliott's Engineering for Land Drainage.....                     | 12mo, 1 50   |
| Practical Farm Drainage.....                                     | 12mo, 1 00   |
| Green's Principles of American Forestry. ( <i>Shortly.</i> )     |              |
| Grotenfelt's Principles of Modern Dairy Practice. (Woll.).....   | 12mo, 2 00   |
| Kemp's Landscape Gardening.....                                  | 12mo, 2 50   |
| Maynard's Landscape Gardening as Applied to Home Decoration..... | 12mo, 1 50   |
| Sanderson's Insects Injurious to Staple Crops.....               | 12mo, 1 50   |
| Insects Injurious to Garden Crops. ( <i>In preparation.</i> )    |              |
| Insects Injuring Fruits. ( <i>In preparation.</i> )              |              |
| Stockbridge's Rocks and Soils.....                               | 8vo, 2 50    |
| Woll's Handbook for Farmers and Dairymen.....                    | 16mo, 1 50   |

## ARCHITECTURE.

|   |            |
|---|------------|
| Baldwin's Steam Heating for Buildings.....                      | 12mo, 2 50 |
| Berg's Buildings and Structures of American Railroads.....      | 4to, 5 00  |
| Birkmire's Planning and Construction of American Theatres.....  | 8vo, 3 00  |
| Architectural Iron and Steel.....                               | 8vo, 3 50  |
| Compound Riveted Girders as Applied in Buildings.....           | 8vo, 2 00  |
| Planning and Construction of High Office Buildings.....         | 8vo, 3 50  |
| Skeleton Construction in Buildings.....                         | 8vo, 3 00  |
| Briggs's Modern American School Buildings.....                  | 8vo, 4 00  |
| Carpenter's Heating and Ventilating of Buildings.....           | 8vo, 4 00  |
| Freitag's Architectural Engineering. 2d Edition, Rewritten..... | 8vo, 3 50  |
| Fireproofing of Steel Buildings.....                            | 8vo, 2 50  |
| French and Ives's Stereotomy.....                               | 8vo, 2 50  |
| Gerhard's Guide to Sanitary House-inspection.....               | 16mo, 1 00 |
| Theatre Fires and Panics.....                                   | 12mo, 1 50 |

|   |                |      |
|---|----------------|------|
| Hatfield's American House Carpenter.....  | 8vo,           | 5 00 |
| Holly's Carpenters' and Joiners' Handbook.....  | 18mo,          | 75   |
| Johnson's Statics by Algebraic and Graphic Methods.....   | 8vo,           | 2 00 |
| Kidder's Architect's and Builder's Pocket-book.....   | 16mo, morocco, | 4 00 |
| Merrill's Stones for Building and Decoration.....   | 8vo,           | 5 00 |
| Monckton's Stair-building.....  | 4to,           | 4 00 |
| Patton's Practical Treatise on Foundations.....   | 8vo,           | 5 00 |
| Siebert and Biggin's Modern Stone-cutting and Masonry.....  | 8vo,           | 1 50 |
| Snow's Principal Species of Wood.....   | 8vo,           | 3 50 |
| Sondericker's Graphic Statics with Applications to Trusses, Beams, and Arches.<br>( <i>Shortly.</i> )   |                |      |
| Wait's Engineering and Architectural Jurisprudence.....   | 8vo,           | 6 00 |
|   | Sheep,         | 6 50 |
| Law of Operations Preliminary to Construction in Engineering and Archi-<br>tecture.....   | 8vo,           | 5 00 |
|   | Sheep,         | 5 50 |
| Law of Contracts.....   | 8vo,           | 3 00 |
| Woodbury's Fire Protection of Mills.....  | 8vo,           | 2 50 |
| Worcester and Atkinson's Small Hospitals, Establishment and Maintenance,<br>Suggestions for Hospital Architecture, with Plans for a Small Hospital. |                |      |
|   | 12mo,          | 1 25 |
| The World's Columbian Exposition of 1893.....   | Large 4to,     | 1 00 |

## ARMY AND NAVY.

|  |                    |       |
|--|--------------------|-------|
| Bernadou's Smokeless Powder, Nitro-cellulose, and the Theory of the Cellulose<br>Molecule..... | 12mo,              | 2 50  |
| * Bruff's Text-book Ordnance and Gunnery.....  | 8vo,               | 6 00  |
| Chase's Screw Propellers and Marine Propulsion.....  | 8vo,               | 3 00  |
| Craig's Azimuth.....   | 4to,               | 3 50  |
| Crehore and Squire's Polarizing Photo-chronograph.....   | 8vo,               | 3 00  |
| Cronkhite's Gunnery for Non-commissioned Officers.....   | 24mo, morocco,     | 2 00  |
| * Davis's Elements of Law.....   | 8vo,               | 2 50  |
| * Treatise on the Military Law of United States.....   | 8vo,               | 7 00  |
| *  | Sheep              | 7 50  |
| De Brack's Cavalry Outpost Duties. (Carr.).....  | 24mo, morocco,     | 2 00  |
| Dietz's Soldier's First Aid Handbook.....  | 16mo, morocco,     | 1 25  |
| * Dredge's Modern French Artillery.....  | 4to, half morocco, | 15 00 |
| Durand's Resistance and Propulsion of Ships.....   | 8vo,               | 5 00  |
| * Dyer's Handbook of Light Artillery.....  | 12mo,              | 3 00  |
| Eissler's Modern High Explosives.....  | 8vo,               | 4 00  |
| * Fiebeger's Text-book on Field Fortification.....   | Small 8vo,         | 2 00  |
| Hamilton's The Gunner's Catechism.....   | 18mo,              | 1 00  |
| * Hoff's Elementary Naval Tactics.....   | 8vo,               | 1 50  |
| Ingalls's Handbook of Problems in Direct Fire.....   | 8vo,               | 4 00  |
| * Ballistic Tables.....  | 8vo,               | 1 50  |
| * Lyons's Treatise on Electromagnetic Phenomena. Vols. I. and II. 8vo, each,                   |                    | 6 00  |
| * Mahan's Permanent Fortifications. (Mercur.).....   | 8vo, half morocco, | 7 50  |
| Manual for Courts-martial.....   | 16mo morocco,      | 1 50  |
| * Mercur's Attack of Fortified Places.....   | 12mo,              | 2 00  |
| * Elements of the Art of War.....  | 8vo,               | 4 00  |
| Metcalf's Cost of Manufactures—And the Administration of Workshops, Public<br>and Private..... | 8vo,               | 5 00  |
| * Ordnance and Gunnery.....  | 12mo,              | 5 00  |
| Murray's Infantry Drill Regulations.....   | 18mo, paper,       | 10    |
| * Phelps's Practical Marine Surveying.....   | 8vo,               | 2 50  |
| Powell's Army Officer's Examiner.....  | 12mo,              | 4 00  |
| Sharpe's Art of Subsisting Armies in War.....  | 18mo, morocco,     | 1 50  |

|   |                |      |
|---|----------------|------|
| * Walke's Lectures on Explosives.....                 | 8vo,           | 4 00 |
| * Wheeler's Siege Operations and Military Mining..... | 8vo,           | 2 00 |
| Winthrop's Abridgment of Military Law.....            | 12mo,          | 2 50 |
| Woodhull's Notes on Military Hygiene.....             | 16mo,          | 1 50 |
| Young's Simple Elements of Navigation.....            | 16mo, morocco, | 1 00 |
| Second Edition, Enlarged and Revised.....             | 16mo, morocco, | 2 00 |

## ASSAYING.

|   |                |      |
|---|----------------|------|
| Fletcher's Practical Instructions in Quantitative Assaying with the Blowpipe..... | 12mo, morocco, | 1 50 |
| Furman's Manual of Practical Assaying.....  | 8vo,           | 3 00 |
| Miller's Manual of Assaying.....  | 12mo,          | 1 00 |
| O'Driscoll's Notes on the Treatment of Gold Ores.....                             | 8vo,           | 2 00 |
| Ricketts and Miller's Notes on Assaying.....                                      | 8vo,           | 3 00 |
| Ulke's Modern Electrolytic Copper Refining.....                                   | 8vo,           | 3 00 |
| Wilson's Cyanide Processes.....   | 12mo,          | 1 50 |
| Chlorination Process.....   | 12mo,          | 1 50 |

## ASTRONOMY.

|  |       |      |
|--|-------|------|
| Comstock's Field Astronomy for Engineers.....                    | 8vo,  | 2 50 |
| Craig's Azimuth.....   | 4to,  | 3 50 |
| Doolittle's Treatise on Practical Astronomy.....                 | 8vo,  | 4 00 |
| Gore's Elements of Geodesy.....                                  | 8vo,  | 2 50 |
| Hayford's Text-book of Geodetic Astronomy.....                   | 8vo,  | 3 00 |
| Merriman's Elements of Precise Surveying and Geodesy.....        | 8vo,  | 2 50 |
| * Michie and Harlow's Practical Astronomy.....                   | 8vo,  | 3 00 |
| * White's Elements of Theoretical and Descriptive Astronomy..... | 12mo, | 2 00 |

## BOTANY.

|  |                |      |
|--|----------------|------|
| Davenport's Statistical Methods, with Special Reference to Biological Variation..... | 16mo, morocco, | 1 25 |
| Thomé and Bennett's Structural and Physiological Botany.....                         | 16mo,          | 2 25 |
| Westermaier's Compendium of General Botany. (Schneider.).....                        | 8vo,           | 2 00 |

## CHEMISTRY.

|   |       |      |
|---|-------|------|
| Adriance's Laboratory Calculations and Specific Gravity Tables.....                     | 12mo, | 1 25 |
| Allen's Tables for Iron Analysis.....   | 8vo,  | 3 00 |
| Arnold's Compendium of Chemistry. (Mandel.) ( <i>In preparation.</i> )                  |       |      |
| Austen's Notes for Chemical Students.....   | 12mo, | 1 50 |
| Bernadou's Smokeless Powder.—Nitro-cellulose, and Theory of the Cellulose Molecule..... | 12mo, | 2 50 |
| Bolton's Quantitative Analysis.....   | 8vo,  | 1 50 |
| * Browning's Introduction to the Rarer Elements.....                                    | 8vo,  | 1 50 |
| Brush and Penfield's Manual of Determinative Mineralogy.....                            | 8vo,  | 4 00 |
| Classen's Quantitative Chemical Analysis by Electrolysis. (Boltwood.)...                | 8vo,  | 3 00 |
| Cohn's Indicators and Test-papers.....  | 12mo, | 2 00 |
| Tests and Reagents.....   | 8vo,  | 3 00 |
| Copeland's Manual of Bacteriology. ( <i>In preparation.</i> )                           |       |      |
| Craft's Short Course in Qualitative Chemical Analysis. (Schaeffer.)....                 | 12mo, | 2 00 |
| Drechsel's Chemical Reactions. (Merrill.).....  | 12mo, | 1 25 |
| Duhem's Thermodynamics and Chemistry. (Burgess.) ( <i>Shortly.</i> )                    |       |      |
| Eissler's Modern High Explosives.....   | 8vo,  | 4 00 |

|   |                             |       |
|---|-----------------------------|-------|
| Effront's Enzymes and their Applications. (Prescott.)   | 8vo,                        | 3 00  |
| Erdmann's Introduction to Chemical Preparations. (Dunlap.)  | 12mo,                       | 1 25  |
| Fletcher's Practical Instructions in Quantitative Assaying with the Blowpipe.                                   | 12mo, morocco,              | 1 50  |
| Fowler's Sewage Works Analyses.   | 12mo,                       | 2 00  |
| Fresenius's Manual of Qualitative Chemical Analysis. (Wells.)   | 8vo,                        | 5 00  |
| Manual of Qualitative Chemical Analysis. Part I. Descriptive. (Wells.)  | 8vo,                        | 3 00  |
| System of Instruction in Quantitative Chemical Analysis. (Cohn.)  | 2 vols. ( <i>Shortly.</i> ) |       |
| Fuertes's Water and Public Health.  | 12mo,                       | 1 50  |
| Furman's Manual of Practical Assaying.  | 8vo,                        | 3 00  |
| Gill's Gas and Fuel Analysis for Engineers.   | 12mo,                       | 1 25  |
| Grotenfelt's Principles of Modern Dairy Practice. (Woll.)   | 12mo,                       | 2 00  |
| Hammarsten's Text-book of Physiological Chemistry. (Mandel.)  | 8vo,                        | 4 00  |
| Helm's Principles of Mathematical Chemistry. (Morgan.)  | 12mo,                       | 1 50  |
| Hinds's Inorganic Chemistry.  | 8vo,                        | 3 00  |
| * Laboratory Manual for Students  | 12mo,                       | 75    |
| Holleman's Text-book of Inorganic Chemistry. (Cooper.)  | 8vo,                        | 2 50  |
| Text-book of Organic Chemistry. (Walker and Mott.)  | 8vo,                        | 2 50  |
| Hopkins's Oil-chemists' Handbook.   | 8vo,                        | 3 00  |
| Jackson's Directions for Laboratory Work in Physiological Chemistry.  | 8vo,                        | 1 00  |
| Keep's Cast Iron.   | 8vo,                        | 2 50  |
| Ladd's Manual of Quantitative Chemical Analysis.  | 12mo,                       | 1 00  |
| Landauer's Spectrum Analysis. (Tingle.)   | 8vo,                        | 3 00  |
| Lassar-Cohn's Practical Urinary Analysis. (Lorenz.)   | 12mo,                       | 1 00  |
| Leach's The Inspection and Analysis of Food with Special Reference to State Control. ( <i>In preparation.</i> ) |                             |       |
| Löb's Electrolysis and Electrosynthesis of Organic Compounds. (Lorenz.)   | 12mo,                       | 1 00  |
| Mandel's Handbook for Bio-chemical Laboratory.  | 12mo,                       | 1 50  |
| Mason's Water-supply. (Considered Principally from a Sanitary Standpoint.)                                      |                             |       |
| 3d Edition, Rewritten.  | 8vo,                        | 4 00  |
| Examination of Water. (Chemical and Bacteriological.)   | 12mo,                       | 1 25  |
| Meyer's Determination of Radicles in Carbon Compounds. (Tingle.)  | 12mo,                       | 1 00  |
| Miller's Manual of Assaying.  | 12mo,                       | 1 00  |
| Mixter's Elementary Text-book of Chemistry.   | 12mo,                       | 1 50  |
| Morgan's Outline of Theory of Solution and its Results.   | 12mo,                       | 1 00  |
| Elements of Physical Chemistry.   | 12mo,                       | 2 00  |
| Nichols's Water-supply. (Considered mainly from a Chemical and Sanitary Standpoint, 1883.)                      | 8vo,                        | 2 50  |
| O'Brine's Laboratory Guide in Chemical Analysis.  | 8vo,                        | 2 00  |
| O'Driscoll's Notes on the Treatment of Gold Ores.   | 8vo,                        | 2 00  |
| Ost and Kolbeck's Text-book of Chemical Technology. (Lorenz—Bozart.)  |                             |       |
| ( <i>In preparation.</i> )  |                             |       |
| * Penfield's Notes on Determinative Mineralogy and Record of Mineral Tests.                                     | 8vo, paper,                 | 50    |
| Pictet's The Alkaloids and their Chemical Constitution. (Biddle.) ( <i>In preparation.</i> )                    |                             |       |
| Pinner's Introduction to Organic Chemistry. (Austen.)   | 12mo,                       | 1 50  |
| Poole's Calorific Power of Fuels.   | 8vo,                        | 3 00  |
| * Reisig's Guide to Piece-dyeing.   | 8vo,                        | 25 00 |
| Richards and Woodman's Air, Water, and Food from a Sanitary Standpoint.   | 8vo,                        | 2 00  |
| Richards's Cost of Living as Modified by Sanitary Science.  | 12mo,                       | 1 00  |
| Cost of Food, a Study in Dietaries.   | 12mo,                       | 1 00  |
| * Richards and Williams's The Dietary Computer.   | 8vo,                        | 1 50  |
| Ricketts and Russell's Skeleton Notes upon Inorganic Chemistry. (Part I.—Non-metallic Elements.)                | 8vo, morocco,               | 75    |
| Ricketts and Miller's Notes on Assaying.  | 8vo,                        | 3 00  |

|  |                |      |
|--|----------------|------|
| Rideal's Sewage and the Bacterial Purification of Sewage.....                            | 8vo,           | 3 50 |
| Ruddiman's Incompatibilities in Prescriptions.....                                       | 8vo,           | 2 00 |
| Schimpf's Text-book of Volumetric Analysis.....  | 12mo,          | 2 50 |
| Spencer's Handbook for Chemists of Beet-sugar Houses.....                                | 16mo, morocco, | 3 00 |
| Handbook for Sugar Manufacturers and their Chemists.....                                 | 16mo, morocco, | 2 00 |
| Stockbridge's Rocks and Soils.....   | 8vo,           | 2 50 |
| * Tillman's Elementary Lessons in Heat.....  | 8vo,           | 1 50 |
| * Descriptive General Chemistry.....   | 8vo            | 3 00 |
| Treadwell's Qualitative Analysis. (Hall.).....   | 8vo,           | 3 00 |
| Turneure and Russell's Public Water-supplies.....  | 8vo,           | 5 00 |
| Van Deventer's Physical Chemistry for Beginners. (Boltwood.).....                        | 12mo,          | 1 50 |
| * Walke's Lectures on Explosives.....  | 8vo,           | 4 00 |
| Wells's Laboratory Guide in Qualitative Chemical Analysis.....                           | 8vo,           | 1 50 |
| Short Course in Inorganic Qualitative Chemical Analysis for Engineering<br>Students..... | 12mo,          | 1 50 |
| Whipple's Microscopy of Drinking-water.....  | 8vo,           | 3 50 |
| Wiechmann's Sugar Analysis.....  | Small 8vo,     | 2 50 |
| Wilson's Cyanide Processes.....  | 12mo,          | 1 50 |
| Chlorination Process.....  | 12mo           | 1 50 |
| Wulling's Elementary Course in Inorganic Pharmaceutical and Medical Chem-<br>istry.....  | 12mo,          | 2 00 |

## CIVIL ENGINEERING.

### BRIDGES AND ROOFS. HYDRAULICS. MATERIALS OF ENGINEERING. RAILWAY ENGINEERING.

|  |  |      |
|--|--|------|
| Baker's Engineers' Surveying Instruments.....  | 12mo,  | 3 00 |
| Bixby's Graphical Computing Table.....   | Paper, 19 $\frac{1}{2}$ X 24 $\frac{1}{2}$ inches. | 25   |
| ** Burr's Ancient and Modern Engineering and the Isthmian Canal. (Postage,<br>27 cents additional.)..... | 8vo, net,  | 3 50 |
| Comstock's Field Astronomy for Engineers.....  | 8vo,   | 2 50 |
| Davis's Elevation and Stadia Tables.....   | 8vo,   | 1 00 |
| Elliott's Engineering for Land Drainage.....   | 12mo,  | 1 50 |
| Practical Farm Drainage.....   | 12mo,  | 1 00 |
| Folwell's Sewerage. (Designing and Maintenance.).....  | 8vo,   | 3 00 |
| Freitag's Architectural Engineering. 2d Edition, Rewritten.....  | 8vo,   | 3 50 |
| French and Ives's Stereotomy.....  | 8vo,   | 2 50 |
| Goodhue's Municipal Improvements.....  | 12mo,  | 1 75 |
| Goodrich's Economic Disposal of Towns' Refuse.....   | 8vo,   | 3 50 |
| Gore's Elements of Geodesy.....  | 8vo,   | 2 50 |
| Hayford's Text-book of Geodetic Astronomy.....   | 8vo,   | 3 00 |
| Howe's Retaining Walls for Earth.....  | 12mo,  | 1 25 |
| Johnson's Theory and Practice of Surveying.....  | Small 8vo,   | 4 00 |
| Statics by Algebraic and Graphic Methods.....  | 8vo,   | 2 00 |
| Kierstedt's Sewage Disposal.....   | 12mo,  | 1 25 |
| Laplace's Philosophical Essay on Probabilities. (Truscott and Emory.).....                               | 12mo,  | 2 00 |
| Mahan's Treatise on Civil Engineering. (1873.) (Wood.).....  | 8vo.   | 5 00 |
| * Descriptive Geometry.....  | 8vo,   | 1 50 |
| Merriman's Elements of Precise Surveying and Geodesy.....  | 8vo,   | 2 50 |
| Elements of Sanitary Engineering.....  | 8vo,   | 2 00 |
| Merriman and Brooks's Handbook for Surveyors.....  | 16mo, morocco,                                     | 2 00 |
| Nugent's Plane Surveying.....  | 8vo,   | 3 50 |
| Ogden's Sewer Design.....  | 12mo,  | 2 00 |
| Patton's Treatise on Civil Engineering.....  | 8vo, half leather,                                 | 7 50 |
| Reed's Topographical Drawing and Sketching.....  | 4to,   | 5 00 |
| Rideal's Sewage and the Bacterial Purification of Sewage.....  | 8vo,   | 3 50 |
| Siebert and Biggin's Modern Stone-cutting and Masonry.....   | 8vo,   | 1 50 |
| Smith's Manual of Topographical Drawing. (McMillan.).....  | 8vo,   | 2 50 |

Sondericker's Graphic Statics, with Applications to Trusses, Beams, and Arches. (*Shortly.*)

|  |                |      |
|--|----------------|------|
| * Trautwine's Civil Engineer's Pocket-book.....                                    | 16mo, morocco, | 5 00 |
| Wait's Engineering and Architectural Jurisprudence.....                            | 8vo,           | 6 00 |
|  | Sheep,         | 6 50 |
| Law of Operations Preliminary to Construction in Engineering and Architecture..... | 8vo,           | 5 00 |
|  | Sheep,         | 5 50 |
| Law of Contracts.....  | 8vo,           | 3 00 |
| Warren's Stereotomy—Problems in Stone-cutting.....                                 | 8vo,           | 2 50 |
| Webb's Problems in the Use and Adjustment of Engineering Instruments.....          | 16mo, morocco, | 1 25 |
| * Wheeler's Elementary Course of Civil Engineering.....                            | 8vo,           | 4 00 |
| Wilson's Topographic Surveying.....  | 8vo,           | 3 50 |

## BRIDGES AND ROOFS.

|  |                |       |
|--|----------------|-------|
| Boiler's Practical Treatise on the Construction of Iron Highway Bridges.....                         | 8vo,           | 2 00  |
| * Thames River Bridge.....   | 4to, paper,    | 5 00  |
| Burr's Course on the Stresses in Bridges and Roof Trusses, Arched Ribs, and Suspension Bridges.....  | 8vo,           | 3 50  |
| Du Bois's Mechanics of Engineering. Vol. II.....   | Small 4to,     | 10 00 |
| Foster's Treatise on Wooden Trestle Bridges.....   | 4to,           | 5 00  |
| Fowler's Cofferdam Process for Piers.....  | 8vo,           | 2 50  |
| Greene's Roof Trusses.....   | 8vo,           | 1 25  |
| Bridge Trusses.....  | 8vo,           | 2 50  |
| Arches in Wood, Iron, and Stone.....   | 8vo,           | 2 50  |
| Howe's Treatise on Arches.....   | 8vo,           | 4 00  |
| Design of Simple Roof-trusses in Wood and Steel.....   | 8vo,           | 2 00  |
| Johnson, Bryan, and Turneure's Theory and Practice in the Designing of Modern Framed Structures..... | Small 4to,     | 10 00 |
| Merriman and Jacoby's Text-book on Roofs and Bridges:  |                |       |
| Part I.—Stresses in Simple Trusses.....  | 8vo,           | 2 50  |
| Part II.—Graphic Statics.....  | 8vo,           | 2 50  |
| Part III.—Bridge Design. 4th Edition, Rewritten.....   | 8vo,           | 2 50  |
| Part IV.—Higher Structures.....  | 8vo,           | 2 50  |
| Morison's Memphis Bridge.....  | 4to,           | 10 00 |
| Waddell's De Pontibus, a Pocket-book for Bridge Engineers.....                                       | 16mo, morocco, | 3 00  |
| Specifications for Steel Bridges.....  | 12mo,          | 1 25  |
| Wood's Treatise on the Theory of the Construction of Bridges and Roofs.....                          | 8vo,           | 2 00  |
| Wright's Designing of Draw-spans:  |                |       |
| Part I. —Plate-girder Draws.....   | 8vo,           | 2 50  |
| Part II.—Riveted-truss and Pin-connected Long-span Draws.....  | 8vo,           | 2 50  |
| Two parts in one volume.....   | 8vo,           | 3 50  |

## HYDRAULICS.

|  |                |      |
|--|----------------|------|
| Bazin's Experiments upon the Contraction of the Liquid Vein Issuing from an Orifice. (Trautwine.)..... | 8vo,           | 2 00 |
| Bovey's Treatise on Hydraulics.....  | 8vo,           | 5 00 |
| Church's Mechanics of Engineering.....   | 8vo,           | 6 00 |
| Diagrams of Mean Velocity of Water in Open Channels.....   | paper,         | 1 50 |
| Coffin's Graphical Solution of Hydraulic Problems.....   | 16mo, morocco, | 2 50 |
| Flather's Dynamometers, and the Measurement of Power.....  | 12mo,          | 3 00 |
| Folwell's Water-supply Engineering.....  | 8vo,           | 4 00 |
| Frizell's Water-power.....   | 8vo,           | 5 00 |

|   |            |       |
|---|------------|-------|
| Fuertes's Water and Public Health. ....   | 12mo,      | 1 50  |
| Water-filtration Works. ....  | 12mo,      | 2 50  |
| Ganguillet and Kutter's General Formula for the Uniform Flow of Water in<br>Rivers and Other Channels. (Hering and Trautwine.)..... | 8vo,       | 4 00  |
| Hazen's Filtration of Public Water-supply. ....   | 8vo,       | 3 00  |
| Hazlehurst's Towers and Tanks for Water-works. ....   | 8vo,       | 2 50  |
| Herschel's 115 Experiments on the Carrying Capacity of Large, Riveted, Metal<br>Conduits. ....                                      | 8vo,       | 2 00  |
| Mason's Water-supply. (Considered Principally from a Sanitary Stand-<br>point.) 3d Edition, Rewritten. ....                         | 8vo,       | 4 00  |
| Merriman's Treatise on Hydraulics. 9th Edition, Rewritten. ....   | 8vo,       | 5 00  |
| * Michie's Elements of Analytical Mechanics. ....   | 8vo,       | 4 00  |
| Schuyler's Reservoirs for Irrigation, Water-power, and Domestic Water-<br>supply. ....  | Large 8vo, | 5 00  |
| ** Thomas and Watt's Improvement of Riyers. (Post., 44 c. additional), 4to,   | 6 00       |       |
| Turneure and Russell's Public Water-supplies. ....  | 8vo,       | 5 00  |
| Wegmann's Design and Construction of Dams. ....   | 4to,       | 5 00  |
| Water-supply of the City of New York from 1658 to 1895. ....  | 4to,       | 10 00 |
| Weisbach's Hydraulics and Hydraulic Motors. (Du Bois.).....   | 8vo,       | 5 00  |
| Wilson's Manual of Irrigation Engineering. ....   | Small 8vo, | 4 00  |
| Wolff's Windmill as a Prime Mover. ....   | 8vo,       | 3 00  |
| Wood's Turbines. ....   | 8vo,       | 2 50  |
| Elements of Analytical Mechanics. ....  | 8vo,       | 3 00  |

## MATERIALS OF ENGINEERING.

|   |             |      |
|---|-------------|------|
| Baker's Treatise on Masonry Construction. ....  | 8vo,        | 5 00 |
| Roads and Pavements. ....   | 8vo,        | 5 00 |
| Black's United States Public Works. ....  | Oblong 4to, | 5 00 |
| Bovey's Strength of Materials and Theory of Structures. ....  | 8vo,        | 7 50 |
| Burr's Elasticity and Resistance of the Materials of Engineering. 6th Edi-<br>tion, Rewritten. .... | 8vo,        | 7 50 |
| Byrne's Highway Construction. ....  | 8vo,        | 5 00 |
| Inspection of the Materials and Workmanship Employed in Construction.                               | 16mo,       | 3 00 |
| Church's Mechanics of Engineering. ....   | 8vo,        | 6 00 |
| Du Bois's Mechanics of Engineering. Vol. I. ....  | Small 4to,  | 7 50 |
| Johnson's Materials of Construction. ....   | Large 8vo,  | 6 00 |
| Keep's Cast Iron. ....  | 8vo,        | 2 50 |
| Lanza's Applied Mechanics. ....   | 8vo,        | 7 50 |
| Martens's Handbook on Testing Materials. (Henning.) 2 vols. ....                                    | 8vo,        | 7 50 |
| Merrill's Stones for Building and Decoration. ....  | 8vo,        | 5 00 |
| Merriman's Text-book on the Mechanics of Materials. ....  | 8vo,        | 4 00 |
| Strength of Materials. ....   | 12mo,       | 1 00 |
| Metcalf's Steel. A Manual for Steel-users. ....   | 12mo,       | 2 00 |
| Patton's Practical Treatise on Foundations. ....  | 8vo,        | 5 00 |
| Rockwell's Roads and Pavements in France. ....  | 12mo,       | 1 25 |
| Smith's Wire: Its Use and Manufacture. ....   | Small 4to,  | 3 00 |
| Materials of Machines. ....   | 12mo,       | 1 00 |
| Snow's Principal Species of Wood. ....  | 8vo,        | 3 50 |
| Spalding's Hydraulic Cement. ....   | 12mo,       | 2 00 |
| Text-book on Roads and Pavements. ....  | 12mo,       | 2 00 |
| Thurston's Materials of Engineering. 3 Parts. ....  | 8vo,        | 8 00 |
| Part I.—Non-metallic Materials of Engineering and Metallurgy. ....                                  | 8vo,        | 2 00 |
| Part II.—Iron and Steel. ....   | 8vo,        | 3 50 |
| Part III.—A Treatise on Brasses, Bronzes, and Other Alloys and their<br>Constituents. ....          | 8vo,        | 2 50 |

|  |               |    |
|--|---------------|----|
| Thurston's Text-book of the Materials of Construction .....  | 8vo, 5        | 00 |
| Tillson's Street Pavements and Paving Materials.....   | 8vo, 4        | 00 |
| Waddell's De Pontibus. (A Pocket-book for Bridge Engineers.)..                                     | 16mo, mor., 3 | 00 |
| Specifications for Steel Bridges.....  | 12mo, 1       | 25 |
| Wood's Treatise on the Resistance of Materials, and an Appendix on the Preservation of Timber..... | 8vo, 2        | 00 |
| Elements of Analytical Mechanics.....  | 8vo, 3        | 00 |

## RAILWAY ENGINEERING.

|  |                |      |
|--|----------------|------|
| Andrews's Handbook for Street Railway Engineers. 3×5 inches. morocco,  | 1              | 25   |
| Berg's Buildings and Structures of American Railroads.....   | 4to,           | 5 00 |
| Brooks's Handbook of Street Railroad Location.....   | 16mo, morocco, | 1 50 |
| Butts's Civil Engineer's Field-book.....   | 16mo, morocco, | 2 50 |
| Crandall's Transition Curve.....   | 16mo, morocco, | 1 50 |
| Railway and Other Earthwork Tables.....  | 8vo,           | 1 50 |
| Dawson's "Engineering" and Electric Traction Pocket-book. 16mo, morocco,   | 4              | 00   |
| Dredge's History of the Pennsylvania Railroad: (1879).....   | Paper,         | 5 00 |
| * Drinker's Tunneling, Explosive Compounds, and Rock Drills, 4to, half mor.,   | 25             | 00   |
| Fisher's Table of Cubic Yards.....   | Cardboard,     | 25   |
| Godwin's Railroad Engineers' Field-book and Explorers' Guide....   | 16mo, mor.,    | 2 50 |
| Howard's Transition Curve Field-book.....  | 16mo morocco   | 1 50 |
| Hudson's Tables for Calculating the Cubic Contents of Excavations and Em-<br>bankments .....                         | 8vo,           | 1 00 |
| Molitor and Beard's Manual for Resident Engineers.....   | 16mo,          | 1 00 |
| Nagle's Field Manual for Railroad Engineers.....   | 16mo, morocco, | 3 00 |
| Philbrick's Field Manual for Engineers.....  | 16mo, morocco, | 3 00 |
| Pratt and Alden's Street-railway Road-bed.....   | 8vo,           | 2 00 |
| Searles's Field Engineering.....   | 16mo, morocco, | 3 00 |
| Railroad Spiral.....   | 16mo, morocco  | 1 50 |
| Taylor's Prismoidal Formulæ and Earthwork.....   | 8vo,           | 1 50 |
| * Trautwine's Method of Calculating the Cubic Contents of Excavations and<br>Embankments by the Aid of Diagrams..... | 8vo,           | 2 00 |
| he Field Practice of [Laying Out Circular Curves for Railroads.  | 12mo, morocco, | 2 50 |
| * Cross-section Sheet.....   | Paper,         | 25   |
| Webb's Railroad Construction. 2d Edition, Rewritten....  | 16mo. morocco, | 5 00 |
| Wellington's Economic Theory of the Location of Railways.....  | Small 8vo,     | 5 00 |

## DRAWING.

|  |               |    |
|--|---------------|----|
| Barr's Kinematics of Machinery.....                          | 8vo, 2        | 50 |
| * Bartlett's Mechanical Drawing. ....                        | 8vo, 3        | 00 |
| Coolidge's Manual of Drawing.....                            | 8vo, paper, 1 | 00 |
| Durley's Kinematics of Machines.....                         | 8vo, 4        | 00 |
| Hill's Text-book on Shades and Shadows, and Perspective..... | 8vo, 2        | 00 |
| Jones's Machine Design:                                      |               |    |
| Part I.—Kinematics of Machinery.....                         | 8vo, 1        | 50 |
| Part II.—Form, Strength, and Proportions of Parts.....       | 8vo, 3        | 00 |
| MacCord's Elements of Descriptive Geometry.....              | 8vo, 3        | 00 |
| Kinematics; or, Practical Mechanism.....                     | 8vo, 5        | 00 |
| Mechanical Drawing.....                                      | 4to, 4        | 00 |
| Velocity Diagrams.....                                       | 8vo, 1        | 50 |
| * Mahan's Descriptive Geometry and Stone-cutting.....        | 8vo, 1        | 50 |
| Industrial Drawing. (Thompson.).....                         | 8vo, 3        | 50 |
| Reed's Topographical Drawing and Sketching.....              | 4to, 5        | 00 |



|   |            |      |
|---|------------|------|
| Reid's Course in Mechanical Drawing.....  | 8vo,       | 2 00 |
| Text-book of Mechanical Drawing and Elementary Machine Design..                 | 8vo,       | 3 00 |
| Robinson's Principles of Mechanism.....   | 8vo,       | 3 00 |
| Smith's Manual of Topographical Drawing. (McMillan.).....                       | 8vo,       | 2 50 |
| Warren's Elements of Plane and Solid Free-hand Geometrical Drawing..            | 12mo,      | 1 00 |
| Drafting Instruments and Operations.....  | 12mo,      | 1 25 |
| Manual of Elementary Projection Drawing.....                                    | 12mo,      | 1 50 |
| Manual of Elementary Problems in the Linear Perspective of Form and Shadow..... | 12mo,      | 1 00 |
| Plane Problems in Elementary Geometry.....                                      | 12mo,      | 1 25 |
| Primary Geometry .....  | 12mo,      | 75   |
| Elements of Descriptive Geometry, Shadows, and Perspective.....                 | 8vo,       | 3 50 |
| General Problems of Shades and Shadows.....                                     | 8vo,       | 3 00 |
| Elements of Machine Construction and Drawing.....                               | 8vo,       | 7 50 |
| Problems, Theorems, and Examples in Descriptive Geometry.....                   | 8vo,       | 2 50 |
| Weisbach's Kinematics and the Power of Transmission. (Hermann and Klein.) ..... | 8vo,       | 5 00 |
| Whelpley's Practical Instruction in the Art of Letter Engraving.....            | 12mo,      | 2 00 |
| Wilson's Topographic Surveying.....   | 8vo,       | 3 50 |
| Free-hand Perspective.....  | 8vo,       | 2 50 |
| Free-hand Lettering. ( <i>In preparation.</i> )                                 |            |      |
| Woolf's Elementary Course in Descriptive Geometry.....                          | Large 8vo, | 3 00 |

## ELECTRICITY AND PHYSICS.

|  |                          |       |
|--|--------------------------|-------|
| Anthony and Brackett's Text-book of Physics. (Magie.).....                   | Small 8vo,               | 3 00  |
| Anthony's Lecture-notes on the Theory of Electrical Measurements....         | 12mo,                    | 1 00  |
| Benjamin's History of Electricity.....                                       | 8vo,                     | 3 00  |
| Voltaic Cell.....  | 8vo,                     | 3 00  |
| Classen's Quantitative Chemical Analysis by Electrolysis. (Boltwood.)..      | 8vo,                     | 3 00  |
| Crehore and Squier's Polarizing Photo-chronograph.....                       | 8vo,                     | 3 00  |
| Dawson's "Engineering" and Electric Traction Pocket-book. 10mo, morocco,     |                          | 4 00  |
| Flather's Dynamometers, and the Measurement of Power.....                    | 12mo,                    | 3 00  |
| Giibert's De Magnete. (Mottelay.).....                                       | 8vo,                     | 2 50  |
| Holman's Precision of Measurements.....                                      | 8vo,                     | 2 00  |
| Telescopic Mirror-scale Method, Adjustments, and Tests....                   | Large 8vo                | 75    |
| Landauer's Spectrum Analysis. (Tingle.).....                                 | 8vo,                     | 3 00  |
| Le Chatelier's High-temperature Measurements. (Boudouard—Burgess.)           | 12mo,                    | 3 00  |
| Löb's Electrolysis and Electrosynthesis of Organic Compounds. (Lorenz.)      | 12mo,                    | 1 00  |
| * Lyons's Treatise on Electromagnetic Phenomena. Vols. I. and II. 8vo, each, |                          | 6 00  |
| * Michie. Elements of Wave Motion Relating to Sound and Light.....           | 8vo,                     | 4 00  |
| Niaudet's Elementary Treatise on Electric Batteries. (Fishback.).....        | 12mo,                    | 2 50  |
| * Parshall and Hobart's Electric Generators.....                             | Small 4to. half morocco, | 10 00 |
| * Rosenberg's Electrical Engineering. (Haldane Gee—Kinzbrunner.)...          | 8vo,                     | 1 50  |
| Ryan, Norris, and Hoxie's Electrical Machinery. ( <i>In preparation.</i> )   |                          |       |
| Thurston's Stationary Steam-engines.....                                     | 8vo,                     | 2 50  |
| * Tillman's Elementary Lessons in Heat.....                                  | 8vo,                     | 1 50  |
| Tory and Pitcher's Manual of Laboratory Physics.....                         | Small 8vo,               | 2 00  |
| Ulke's Modern Electrolytic Copper Refining .....                             | 8vo,                     | 3 00  |

## LAW.

|  |                |      |
|--|----------------|------|
| * Davis's Elements of Law .....                      | 8vo,           | 2 50 |
| * Treatise on the Military Law of United States..... | 8vo,           | 7 00 |
| * .....  | Sheep,         | 7 50 |
| Manual for Courts-martial.....                       | 16mo, morocco, | 1 50 |

|  |        |      |
|--|--------|------|
| Wait's Engineering and Architectural Jurisprudence.....                            | 8vo,   | 6 00 |
|  | Sheep, | 6 50 |
| Law of Operations Preliminary to Construction in Engineering and Architecture..... | 8vo,   | 5 00 |
|  | Sheep, | 5 50 |
| Law of Contracts.....  | 8vo,   | 3 00 |
| Winthrop's Abridgment of Military Law.....   | 12mo,  | 2 50 |

## MANUFACTURES.

|   |                |       |
|---|----------------|-------|
| Bernadou's Smokeless Powder—Nitro-cellulose and Theory of the Cellulose Molecule.....                                 | 12mo,          | 2 50  |
| Bolland's Iron Founder.....   | 12mo,          | 2 50  |
| "The Iron Founder," Supplement.....   | 12mo,          | 2 50  |
| Encyclopedia of Founding and Dictionary of Foundry Terms Used in the Practice of Moulding.....                        | 12mo,          | 3 00  |
| Eissler's Modern High Explosives.....   | 8vo,           | 4 00  |
| Effront's Enzymes and their Applications. (Prescott.).....  | 8vo,           | 3 00  |
| Fitzgerald's Boston Machinist.....  | 18mo,          | 1 00  |
| Ford's Boiler Making for Boiler Makers.....   | 18mo,          | 1 00  |
| Hopkins's Oil-chemists' Handbook.....   | 8vo,           | 3 00  |
| Keep's Cast Iron.....   | 8vo,           | 2 50  |
| Leach's The Inspection and Analysis of Food, with Special Reference to State Control. ( <i>In preparation.</i> )..... |                |       |
| Metcalf's Steel. A Manual for Steel-users.....  | 12mo,          | 2 00  |
| Metcalf's Cost of Manufactures—And the Administration of Workshops, Public and Private.....                           | 8vo,           | 5 00  |
| Meyer's Modern Locomotive Construction.....   | 4to,           | 10 00 |
| * Reisig's Guide to Piece-dyeing.....   | 8vo,           | 25 00 |
| Smith's Press-working of Metals.....  | 8vo,           | 3 00  |
| Wire: Its Use and Manufacture.....  | Small 4to,     | 3 00  |
| Spalding's Hydraulic Cement.....  | 12mo,          | 2 00  |
| Spencer's Handbook for Chemists of Beet-sugar Houses.....   | 16mo, morocco, | 3 00  |
| andbook for Sugar Manufacturers and their Chemists.....   | 16mo, morocco, | 2 00  |
| Thurston's Manual of Steam-boilers, their Designs, Construction and Operation.....                                    | 8vo,           | 5 00  |
| * Walke's Lectures on Explosives.....   | 8vo,           | 4 00  |
| West's American Foundry Practice.....   | 12mo,          | 2 50  |
| Moulder's Text-book.....  | 12mo,          | 2 50  |
| Wiechmann's Sugar Analysis.....   | Small 8vo,     | 2 50  |
| Wolff's Windmill as a Prime Mover.....  | 8vo,           | 3 00  |
| Woodbury's Fire Protection of Mills.....  | 8vo,           | 2 50  |

## MATHEMATICS.

|  |             |      |
|--|-------------|------|
| Baker's Elliptic Functions.....                          | 8vo,        | 1 50 |
| * Bass's Elements of Differential Calculus.....          | 12mo,       | 4 00 |
| Briggs's Elements of Plane Analytic Geometry.....        | 12mo,       | 1 00 |
| Chapman's Elementary Course in Theory of Equations.....  | 12mo,       | 1 50 |
| Compton's Manual of Logarithmic Computations.....        | 12mo,       | 1 50 |
| Davis's Introduction to the Logic of Algebra.....        | 8vo,        | 1 50 |
| * Dickson's College Algebra.....                         | Large 12mo, | 1 50 |
| * Introduction to the Theory of Algebraic Equations..... | Large 12mo, | 1 25 |
| Halsted's Elements of Geometry.....                      | 8vo,        | 1 75 |
| Elementary Synthetic Geometry.....                       | 8vo,        | 1 50 |

|  |                |      |
|--|----------------|------|
| * Johnson's Three-place Logarithmic Tables: Vest-pocket size.....                    | paper,         | 15   |
|  | 100 copies for | 5 00 |
| * Mounted on heavy cardboard, 8×10 inches,   |                | 25   |
|  | 10 copies for  | 2 00 |
| Elementary Treatise on the Integral Calculus.....                                    | Small 8vo,     | 1 50 |
| Curve Tracing in Cartesian Co-ordinates.....   | 12mo,          | 1 00 |
| Treatise on Ordinary and Partial Differential Equations.....                         | Small 8vo,     | 3 50 |
| Theory of Errors and the Method of Least Squares.....                                | 12mo,          | 1 50 |
| * Theoretical Mechanics.....   | 12mo,          | 3 00 |
| Laplace's Philosophical Essay on Probabilities. (Truscott and Emory.)                | 12mo,          | 2 00 |
| * Ludlow and Bass. Elements of Trigonometry and Logarithmic and Other<br>Tables..... | 8vo,           | 3 00 |
| Trigonometry and Tables published separately.....                                    | Each,          | 2 00 |
| Maurer's Technical Mechanics. ( <i>In preparation.</i> )                             |                |      |
| Merriman and Woodward's Higher Mathematics.....                                      | 8vo,           | 5 00 |
| Merriman's Method of Least Squares.....  | 8vo,           | 2 00 |
| Rice and Johnson's Elementary Treatise on the Differential Calculus. Sm.,            | 8vo,           | 3 00 |
| Differential and Integral Calculus. 2 vols. in one.....                              | Small 8vo,     | 2 50 |
| Wood's Elements of Co-ordinate Geometry.....   | 8vo,           | 2 00 |
| Trigonometry: Analytical, Plane, and Spherical.....                                  | 12mo,          | 1 00 |

## MECHANICAL ENGINEERING.

### MATERIALS OF ENGINEERING, STEAM-ENGINES AND BOILERS.

|  |                |      |
|--|----------------|------|
| Baldwin's Steam Heating for Buildings.....                                       | 12mo,          | 2 50 |
| Barr's Kinematics of Machinery.....  | 8vo,           | 2 50 |
| * Bartlett's Mechanical Drawing.....   | 8vo,           | 3 00 |
| Benjamin's Wrinkles and Recipes.....   | 12mo,          | 2 00 |
| Carpenter's Experimental Engineering.....  | 8vo,           | 6 00 |
| Heating and Ventilating Buildings.....   | 8vo,           | 4 00 |
| Clerk's Gas and Oil Engine.....  | Small 8vo,     | 4 00 |
| Coolidge's Manual of Drawing.....  | 8vo, paper,    | 1 00 |
| Cromwell's Treatise on Toothed Gearing.....                                      | 12mo,          | 1 50 |
| Treatise on Belts and Pulleys.....   | 12mo,          | 1 50 |
| Durley's Kinematics of Machines.....   | 8vo,           | 4 00 |
| Flather's Dynamometers and the Measurement of Power.....                         | 12mo,          | 3 00 |
| Rope Driving.....  | 12mo,          | 2 00 |
| Gill's Gas and Fuel Analysis for Engineers.....                                  | 12mo,          | 1 25 |
| Hall's Car Lubrication.....  | 12mo,          | 1 00 |
| Hutton's The Gas Engine. ( <i>In preparation.</i> )                              |                |      |
| Jones's Machine Design:  |                |      |
| Part I.—Kinematics of Machinery.....   | 8vo,           | 1 50 |
| Part II.—Form, Strength, and Proportions of Parts.....                           | 8vo,           | 3 00 |
| Kent's Mechanical Engineer's Pocket-book.....                                    | 16mo, morocco, | 5 00 |
| Kerr's Power and Power Transmission.....   | 8vo,           | 2 00 |
| MacCord's Kinematics; or, Practical Mechanism.....                               | 8vo,           | 5 00 |
| Mechanical Drawing.....  | 4to,           | 4 00 |
| Velocity Diagrams.....   | 8vo,           | 1 50 |
| Mahan's Industrial Drawing. (Thompson.).....                                     | 8vo,           | 3 50 |
| Poole's Calorific Power of Fuels.....  | 8vo,           | 3 00 |
| Reid's Course in Mechanical Drawing.....   | 8vo,           | 2 00 |
| Text-book of Mechanical Drawing and Elementary Machine Design.....               | 8vo,           | 3 00 |
| Richards's Compressed Air.....   | 12mo,          | 1 50 |
| Robinson's Principles of Mechanism.....  | 8vo,           | 3 00 |
| Smith's Press-working of Metals.....   | 8vo,           | 3 00 |
| Thurston's Treatise on Friction and Lost Work in Machinery and Mill<br>Work..... | 8vo,           | 3 00 |
| Animal as a Machine and Prime Motor, and the Laws of Energetics.....             | 12mo,          | 1 00 |

|  |      |                 |
|--|------|-----------------|
| Warren's Elements of Machine Construction and Drawing.....                     | 8vo, | 7 50            |
| Weisbach's Kinematics and the Power of Transmission. Herrmann—<br>Klein.)..... | 8vo, | 5 <sup>00</sup> |
| Machinery of Transmission and Governors. (Herrmann—Klein.).....                | 8vo, | 5 00            |
| Hydraulics and Hydraulic Motors. (Du Bois.).....                               | 8vo, | 5 00            |
| Wolff's Windmill as a Prime Mover.....   | 8vo, | 3 00            |
| Wood's Turbines.....   | 8vo, | 2 50            |

## MATERIALS OF ENGINEERING.

|  |               |      |
|--|---------------|------|
| Bovey's Strength of Materials and Theory of Structures.....  | 8vo,          | 7 50 |
| Burr's Elasticity and Resistance of the Materials of Engineering. 6th Edition,<br>Reset.....         | 8vo,          | 7 50 |
| Church's Mechanics of Engineering.....   | 8vo,          | 6 00 |
| Johnson's Materials of Construction.....   | Large 8vo,    | 6 00 |
| Keep's Cast Iron.....  | 8vo,          | 2 50 |
| Lanza's Applied Mechanics.....   | 8vo,          | 7 50 |
| Martens's Handbook on Testing Materials. (Henning.).....   | 8vo,          | 7 50 |
| Merriman's Text-book on the Mechanics of Materials.....  | 8vo,          | 4 00 |
| Strength of Materials.....   | 12mo,         | 1 00 |
| Metcalf's Steel. A Manual for Steel-users.....   | 12mo,         | 2 00 |
| Smith's Wire: Its Use and Manufacture.....   | Small 4to,    | 3 00 |
| Materials of Machines.....   | 12mo,         | 1 00 |
| Thurston's Materials of Engineering.....   | 3 vols., 8vo, | 8 00 |
| Part II.—Iron and Steel.....   | 8vo,          | 3 50 |
| Part III.—A Treatise on Brasses, Bronzes, and Other Alloys and their<br>Constituents.....            | 8vo,          | 2 50 |
| Text-book of the Materials of Construction.....  | 8vo,          | 5 00 |
| Wood's Treatise on the Resistance of Materials and an Appendix on the<br>Preservation of Timber..... | 8vo,          | 2 00 |
| Elements of Analytical Mechanics.....  | 8vo,          | 3 00 |

## STEAM-ENGINES AND BOILERS.

|   |             |       |
|---|-------------|-------|
| Carnot's Reflections on the Motive Power of Heat. (Thurston.).....                              | 12mo,       | 1 50  |
| Dawson's "Engineering" and Electric Traction Pocket-book.....                                   | 16mo, mor., | 4 00  |
| Ford's Boiler Making for Boiler Makers.....   | 18mo,       | 1 00  |
| Goss's Locomotive Sparks.....   | 8vo,        | 2 00  |
| Hemenway's Indicator Practice and Steam-engine Economy.....                                     | 12mo,       | 2 00  |
| Hutton's Mechanical Engineering of Power Plants.....  | 8vo,        | 5 00  |
| Heat and Heat-engines.....  | 8vo,        | 5 00  |
| Kent's Steam-boiler Economy.....  | 8vo,        | 4 00  |
| Kneass's Practice and Theory of the Injector.....   | 8vo,        | 1 50  |
| MacCord's Slide-valves.....   | 8vo,        | 2 00  |
| Meyer's Modern Locomotive Construction.....   | 4to,        | 10 00 |
| Peabody's Manual of the Steam-engine Indicator.....   | 12mo,       | 1 50  |
| Tables of the Properties of Saturated Steam and Other Vapors.....                               | 8vo,        | 1 00  |
| Thermodynamics of the Steam-engine and Other Heat-engines.....                                  | 8vo,        | 5 00  |
| Valve-gears for Steam-engines.....  | 8vo,        | 2 50  |
| Peabody and Miller's Steam-boilers.....   | 8vo,        | 4 00  |
| Pray's Twenty Years with the Indicator.....   | Large 8vo,  | 2 50  |
| Pupln's Thermodynamics of Reversible Cycles in Gases and Saturated Vapors.<br>(Osterberg.)..... | 12mo,       | 1 25  |
| Reagan's Locomotives: Simple, Compound, and Electric.....                                       | 12mo,       | 2 50  |
| Rontgen's Principles of Thermodynamics. (Du Bois.).....   | 8vo,        | 5 00  |
| Sinclair's Locomotive Engine Running and Management.....  | 12mo,       | 2 00  |
| Smart's Handbook of Engineering Laboratory Practice.....  | 12mo,       | 2 50  |
| Snow's Steam-boiler Practice.....   | 8vo,        | 3 00  |

|   |                    |
|---|--------------------|
| Spangler's Valve-gears.....   | 8vo, 2 50          |
| Notes on Thermodynamics.....  | 12mo, 1 00         |
| Spangler, Greene, and Marshall's Elements of Steam-engineing.....                           | 8vo, 3 00          |
| Thurston's Handy Tables.....  | 8vo, 1 50          |
| Manual of the Steam-engine.....   | 2 vols. 8vo, 10 00 |
| Part I.—History, Structure, and Theory.....   | 8vo, 6 00          |
| Part II.—Design, Construction, and Operation.....   | 8vo, 6 00          |
| Handbook of Engine and Boiler Trials, and the Use of the Indicator and the Prony Brake..... | 8vo, 5 00          |
| Stationary Steam-engines.....   | 8vo, 2 50          |
| Steam-boiler Explosions in Theory and in Practice.....                                      | 12mo, 1 50         |
| Manual of Steam-boilers, Their Designs, Construction, and Operation.....                    | 8vo, 5 00          |
| Weisbach's Heat, Steam, and Steam-engines. (Du Bois.).....                                  | 8vo, 5 00          |
| Whitham's Steam-engine Design.....  | 8vo, 5 00          |
| Wilson's Treatise on Steam-boilers. (Flather.).....   | 16mo, 2 50         |
| Wood's Thermodynamics, Heat Motors, and Refrigerating Machines....                          | 8vo, 4 00          |

## MECHANICS AND MACHINERY.

|  |                         |
|--|-------------------------|
| Barr's Kinematics of Machinery.....  | 8vo, 2 50               |
| Bovey's Strength of Materials and Theory of Structures.....  | 8vo, 7 50               |
| Chase's The Art of Pattern-making.....   | 12mo, 2 50              |
| Chordal.—Extracts from Letters.....  | 12mo, 2 00              |
| Church's Mechanics of Engineering.....   | 8vo, 6 00               |
| Notes and Examples in Mechanics.....   | 8vo, 2 00               |
| Compton's First Lessons in Metal-working.....  | 12mo, 1 50              |
| Compton and De Groodt's The Speed Lathe.....   | 12mo, 1 50              |
| Cromwell's Treatise on Toothed Gearing.....  | 12mo, 1 50              |
| Treatise on Belts and Pulleys.....   | 12mo, 1 50              |
| Dana's Text-book of Elementary Mechanics for the Use of Colleges and Schools.....                        | 12mo, 1 50              |
| Dingey's Machinery Pattern Making.....   | 12mo, 2 00              |
| Dredge's Record of the Transportation Exhibits Building of the World's Columbian Exposition of 1893..... | 4to, half morocco, 5 00 |
| Du Bois's Elementary Principles of Mechanics:  |                         |
| Vol. I.—Kinematics.....  | 8vo, 3 50               |
| Vol. II.—Statics.....  | 8vo, 4 00               |
| Vol. III.—Kinetics.....  | 8vo, 3 50               |
| Mechanics of Engineering. Vol. I.....  | Small 4to, 7 50         |
| Vol. II.....   | Small 4to, 10 00        |
| Durley's Kinematics of Machines.....   | 8vo, 4 00               |
| Fitzgerald's Boston Machinist.....   | 16mo, 1 00              |
| Flather's Dynamometers, and the Measurement of Power.....  | 12mo, 3 00              |
| Rope Driving.....  | 12mo, 2 00              |
| Goss's Locomotive Sparks.....  | 8vo, 2 00               |
| Hall's Car Lubrication.....  | 12mo, 1 00              |
| Holly's Art of Saw Filing.....   | 18mo, 75                |
| * Johnson's Theoretical Mechanics.....   | 12mo, 3 00              |
| Statics by Graphic and Algebraic Methods.....  | 8vo, 2 00               |
| Jones's Machine Design:  |                         |
| Part I.—Kinematics of Machinery.....   | 8vo, 1 50               |
| Part II.—Form, Strength, and Proportions of Parts.....   | 8vo, 3 00               |
| Kerr's Power and Power Transmission.....   | 8vo, 2 00               |
| Lanza's Applied Mechanics.....   | 8vo, 7 50               |
| MacCord's Kinematics; or, Practical Mechanism.....   | 8vo, 5 00               |
| Velocity Diagrams.....   | 8vo, 1 50               |
| Maurer's Technical Mechanics. ( <i>In preparation.</i> )   |                         |

|   |       |      |
|---|-------|------|
| Merriman's Text-book on the Mechanics of Materials.....                       | 8vo,  | 4 00 |
| * Michie's Elements of Analytical Mechanics.....                              | 8vo,  | 4 00 |
| Reagan's Locomotives: Simple, Compound, and Electric.....                     | 12mo, | 2 50 |
| Reid's Course in Mechanical Drawing.....                                      | 8vo,  | 2 00 |
| Text-book of Mechanical Drawing and Elementary Machine Design.....            | 8vo,  | 3 00 |
| Richards's Compressed Air.....  | 12mo, | 1 50 |
| Robinson's Principles of Mechanism.....                                       | 8vo,  | 3 00 |
| Ryan, Norris, and Hoxie's Electrical Machinery. ( <i>In preparation.</i> )    |       |      |
| Sinclair's Locomotive-engine Running and Management.....                      | 12mo, | 2 00 |
| Smith's Press-working of Metals.....  | 8vo,  | 3 00 |
| Materials of Machines.....  | 12mo, | 1 00 |
| Spangler, Greene, and Marshall's Elements of Steam-engineering.....           | 8vo,  | 3 00 |
| Thurston's Treatise on Friction and Lost Work in Machinery and Mill Work..... | 8vo,  | 3 00 |
| Animal as a Machine and Prime Motor, and the Laws of Energetics.....          | 12mo, | 1 00 |
| Warren's Elements of Machine Construction and Drawing.....                    | 8vo,  | 7 50 |
| Weisbach's Kinematics and the Power of Transmission. (Herrmann—Klein.).....   | 8vo,  | 5 00 |
| Machinery of Transmission and Governors. (Herrmann—Klein.).....               | 8vo,  | 5 00 |
| Wood's Elements of Analytical Mechanics.....                                  | 8vo,  | 3 00 |
| Principles of Elementary Mechanics.....                                       | 12mo, | 1 25 |
| Turbines.....   | 8vo,  | 2 50 |
| The World's Columbian Exposition of 1893.....                                 | 4to,  | 1 00 |

## METALLURGY.

Egleston's Metallurgy of Silver, Gold, and Mercury:

|  |       |      |
|--|-------|------|
| Vol. I.—Silver.....  | 8vo,  | 7 50 |
| Vol. II.—Gold and Mercury.....   | 8vo,  | 7 50 |
| ** Iles's Lead-smelting. (Postage 9 cents additional.).....                            | 12mo, | 2 50 |
| Keep's Cast Iron.....  | 8vo,  | 2 50 |
| Kunhardt's Practice of Ore Dressing in Europe.....                                     | 8vo,  | 1 50 |
| Le Chatelier's High-temperature Measurements. (Boudouard—Burgess.).....                | 12mo, | 3 00 |
| Metcalf's Steel. A Manual for Steel-users.....   | 12mo, | 2 00 |
| Smith's Materials of Machines.....   | 12mo, | 1 00 |
| Thurston's Materials of Engineering. In Three Parts.....                               | 8vo,  | 8 00 |
| Part II.—Iron and Steel.....   | 8vo,  | 3 50 |
| Part III.—A Treatise on Brasses, Bronzes, and Other Alloys and their Constituents..... | 8vo,  | 2 50 |
| Ulke's Modern Electrolytic Copper Refining.....  | 8vo,  | 3 00 |

## MINERALOGY.

|   |                          |       |
|---|--------------------------|-------|
| Barringer's Description of Minerals of Commercial Value.      | Oblong, morocco,         | 2 50  |
| Boyd's Resources of Southwest Virginia.....                   | 8vo,                     | 3 00  |
| Map of Southwest Virginia.....                                | Pocket-book form,        | 2 00  |
| Brush's Manual of Determinative Mineralogy. (Penfield.).....  | 8vo,                     | 4 00  |
| Chester's Catalogue of Minerals.....                          | 8vo, paper,              | 1 00  |
|   | Cloth,                   | 1 25  |
| Dictionary of the Names of Minerals.....                      | 8vo,                     | 3 50  |
| Dana's System of Mineralogy.....                              | Large 8vo, half leather, | 12 50 |
| First Appendix to Dana's New "System of Mineralogy."....      | Large 8vo,               | 1 00  |
| Text-book of Mineralogy.....                                  | 8vo,                     | 4 00  |
| Minerals and How to Study Them.....                           | 12mo,                    | 1 50  |
| Catalogue of American Localities of Minerals.....             | Large 8vo,               | 1 00  |
| Manual of Mineralogy and Petrography.....                     | 12mo,                    | 2 00  |
| Egleston's Catalogue of Minerals and Synonyms.....            | 8vo,                     | 2 50  |
| Hussak's The Determination of Rock-forming Minerals. (Smith.) | Small 8vo,               | 2 00  |

|  |             |      |
|--|-------------|------|
| * Penfield's Notes on Determinative Mineralogy and Record of Mineral Tests.        | 8vo, paper, | 0 50 |
| Rosenbusch's Microscopical Physiography of the Rock-making Minerals.<br>(Iddings.) | 8vo,        | 5 00 |
| * Tillman's Text-book of Important Minerals and Docks.                             | 8vo,        | 2 00 |
| Williams's Manual of Lithology.  | 8vo,        | 3 00 |

## MINING.

|  |                    |       |
|--|--------------------|-------|
| Beard's Ventilation of Mines.                                    | 12mo,              | 2 50  |
| Boyd's Resources of Southwest Virginia.                          | 8vo,               | 3 00  |
| Map of Southwest Virginia.                                       | Pocket-book form,  | 2 00  |
| * Drinker's Tunneling, Explosive Compounds, and Rock Drills.     | 4to, half morocco, | 25 00 |
| Eissler's Modern High Explosives.                                | 8vo,               | 4 00  |
| Fowler's Sewage Works Analyses.                                  | 12mo,              | 2 00  |
| Goodyear's Coal-mines of the Western Coast of the United States. | 12mo,              | 2 50  |
| Ihlseng's Manual of Mining.                                      | 8vo,               | 4 00  |
| ** Iles's Lead-smelting. (Postage 9c. additional.)               | 12mo,              | 2 50  |
| Kunhardt's Practice of Ore Dressing in Europe.                   | 8vo,               | 1 50  |
| O'Driscoll's Notes on the Treatment of Gold Ores.                | 8vo,               | 2 00  |
| * Walke's Lectures on Explosives.                                | 8vo,               | 4 00  |
| Wilson's Cyanide Processes.                                      | 12mo,              | 1 50  |
| Chlorination Process.  | 12mo,              | 1 50  |
| Hydraulic and Placer Mining.                                     | 12mo,              | 2 00  |
| Treatise on Practical and Theoretical Mine Ventilation.          | 12mo,              | 1 25  |

## SANITARY SCIENCE.

|   |           |      |
|---|-----------|------|
| Copeland's Manual of Bacteriology. ( <i>In preparation.</i> )   |           |      |
| Folwell's Sewerage. (Designing, Construction, and Maintenance.)   | 8vo,      | 3 00 |
| Water-supply Engineering.   | 8vo,      | 4 00 |
| Fuertes's Water and Public Health.  | 12mo,     | 1 50 |
| Water-filtration Works.   | 12mo,     | 2 50 |
| Gerhard's Guide to Sanitary House-inspection.   | 16mo,     | 1 00 |
| Goodrich's Economical Disposal of Town's Refuse.  | Demy 8vo, | 3 50 |
| Hazen's Filtration of Public Water-supplies.  | 8vo,      | 3 00 |
| Kiersted's Sewage Disposal.   | 12mo,     | 1 25 |
| Leach's The Inspection and Analysis of Food with Special Reference to State Control. ( <i>In preparation.</i> ) |           |      |
| Mason's Water-supply. (Considered Principally from a Sanitary Standpoint.) 3d Edition, Rewritten.               | 8vo,      | 4 00 |
| Examination of Water. (Chemical and Bacteriological.)   | 12mo,     | 1 25 |
| Merriman's Elements of Sanitary Engineering.  | 8vo,      | 2 00 |
| Nichols's Water-supply. (Considered Mainly from a Chemical and Sanitary Standpoint.) (1883.)                    | 8vo,      | 2 50 |
| Ogden's Sewer Design.   | 12mo,     | 2 00 |
| * Price's Handbook on Sanitation.   | 12mo,     | 1 50 |
| Richards's Cost of Food. A Study in Dietaries.  | 12mo,     | 1 00 |
| Cost of Living as Modified by Sanitary Science  | 12mo,     | 1 00 |
| Richards and Woodman's Air, Water, and Food from a Sanitary Standpoint.   | 8vo,      | 2 00 |
| * Richards and Williams's The Dietary Computer.   | 8vo,      | 1 50 |
| Rideal's Sewage and Bacterial Purification of Sewage.   | 8vo,      | 3 50 |
| Turneure and Russell's Public Water-supplies.   | 8vo,      | 5 00 |
| Whipple's Microscopy of Drinking-water.   | 8vo,      | 3 50 |
| Woodhull's Notes and Military Hygiene.  | 16mo,     | 1 50 |

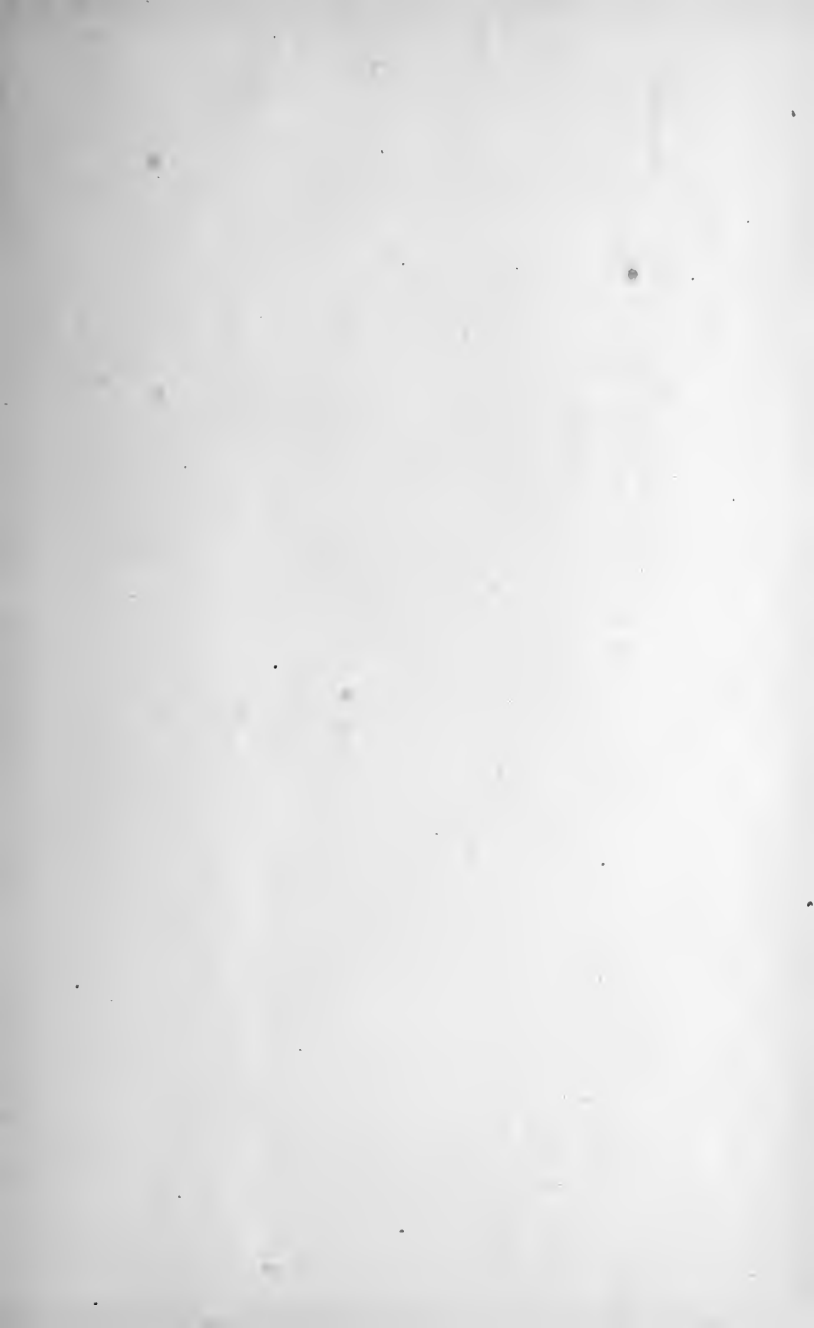
## MISCELLANEOUS.

|   |            |      |
|---|------------|------|
| Barker's Deep-sea Soundings.....  | 8vo,       | 2 00 |
| Emmons's Geological Guide-book of the Rocky Mountain Excursion of the<br>International Congress of Geologists.....  | Large 8vo, | 1 50 |
| Ferrel's Popular Treatise on the Winds.....   | 8vo,       | 4 00 |
| Haines's American Railway Management.....   | 12mo,      | 2 50 |
| Mott's Composition, Digestibility, and Nutritive Value of Food. Mounted chart.  |            | 1 25 |
| Fallacy of the Present Theory of Sound.....   | 16mo,      | 1 00 |
| Ricketts's History of Rensselaer Polytechnic Institute, 1824-1894. Small  | 8vo,       | 3 00 |
| Rotherham's Emphasized New Testament.....   | Large 8vo, | 2 00 |
| Steel's Treatise on the Diseases of the Dog.....  | 8vo,       | 3 50 |
| Totten's Important Question in Metrology.....   | 8vo,       | 2 50 |
| The World's Columbian Exposition of 1893.....   | 4to,       | 1 00 |
| Worcester and Atkinson. Small Hospitals, Establishment and Maintenance,<br>and Suggestions for Hospital Architecture, with Plans for a Small<br>Hospital..... | 12mo,      | 1 25 |

## HEBREW AND CHALDEE TEXT-BOOKS.

|   |                          |      |
|---|--------------------------|------|
| Green's Grammar of the Hebrew Language.....   | 8vo,                     | 3 00 |
| Elementary Hebrew Grammar.....  | 12mo,                    | 1 25 |
| Hebrew Chrestomathy.....  | 8vo,                     | 2 00 |
| Gesenius's Hebrew and Chaldee Lexicon to the Old Testament Scriptures.<br>(Tregelles.)..... | Small 4to, half morocco, | 5 00 |
| Letteris's Hebrew Bible.....  | 8vo,                     | 2 25 |





'APR 2 1904







LIBRARY OF CONGRESS



0 021 218 298 9